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DAILY EDITION

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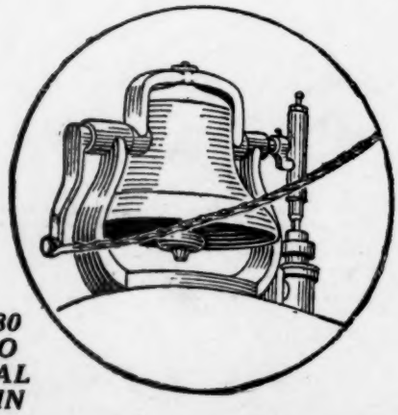

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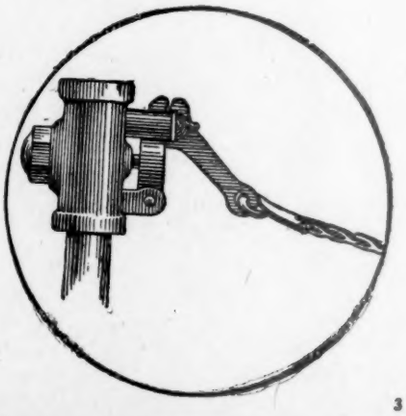

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Railway Age

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WE GUARANTEE that of this issue, 15,000 copies were printed; that of these 15,000 copies, 13,480 were mailed to regular paid subscribers to the Railway Age and the Railway Mechanical Engineer; 140 were mailed to advertisers, 280 were provided for counter and news companies' sales, new subscriptions, bound volumes, samples, copies lost in the mail and office use; and 1,100 copies for distribution at Atlantic City.

THE RAILWAY AGE is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulations (A. B. C.).

No one can be accused of lack of forethought in not having the convention hall enlarged this year. Nevertheless, there may be some difficulty in accommodating all the members on Monday when the subjects common to both the locomotive and car departments are considered. At Wednesday's session there was hardly a vacant seat in the Greek Temple. It is safe to say that this has never happened before, with the exception of the opening session, when supply men as well as railroad members were in attendance. No stronger endorsement of the policy of the officers of the association could be given than is furnished by the record breaking attendance and the sustained interest at the meetings.

Standing Room Only

Much has been said recently relative to the marked decrease in the efficiency of labor, which is seriously affecting the output of railroad shops. It is generally conceded, not only with respect to railroad shops but in most industrial establishments, that there has been a material falling off in man-hour output since the war. The possibilities for increasing output do not, however, lie wholly with the men. It is a serious question whether the actual loss of production chargeable to the men, while actually at a job, is as great as the loss of time between jobs, for a large part of which they are in no way responsible. Under piece work conditions the men had an incentive to assume a portion of the responsibility which rightly belongs to the shop management. Their own interest in output was sufficient to cause them to take measures themselves to see that material and tools were properly lined up so that the jobs might proceed with the least possible interruption. This should be the duty of the management and by proper supervision, especially by the use of a scheduling, routing and material follow-up system, this class of delays can largely be eliminated. Present conditions are such that the supervision of any large shop can ill afford not to include such a system. Once established, it is extreely doubtful whether any shop management would consent to discontinue it even under a complete restoration to pre-war conditions.

Reduce the Time Between Jobs

The fact that there was so little apparent interest shown in the report of the Committee on the Design, Maintenance and Operation of Electric Rolling Stock indicates that there is a need for a change of method in handling such subjects. J. A. Pilcher presented the report in the absence of the chairman, C. H. Quereau. He likened electric motive power to a bucket conveyor because of its certainty of movement and constant speed. One train, he said, will not catch up with another on the road. W. J. Tollerton called for discussion, stating that this was an important question, particularly in view of the water power bill just passed by Congress and the need for fuel conservation, but there was no response to his request. The report dealt with the matter of electrification largely as a matter of economics instead of one of maintenance, design and operation, but the fact that no one felt willing to start the discussion was in itself significant. Beyond question it is a topic of rapidly increasing importance, and while comparatively few roads use electric rolling stock, a number are considering its use, and there are other electrical subjects of equal or greater importance. Some means should be provided so that electrical matters can be handled more adequately and the attention of the men most vitally interested in them be concentrated on them.

Consideration of Things Electrical

If the railroads really want college men in their shops the way is open. Does the National Agreement actually prohibit the employment of special apprentices recruited from the universities or their training along lines calculated to develop capable and efficient shop executives? It is impossible to find any real basis for interpreting the agreement in such a way as to keep the college man out of the shop if the railroads really want him. The agreement simply ignores him—why read into it something that is not there and which has no place in such an agreement? It has been suggested that the real question is, "Do the railroads really want the college man?" That is the test. Is he accepted at his real value and genuinely wanted? It is suspected that on more than one road he is ostensibly welcome, but practically *persona non grata.* But assuming that the railroads appreciate the potential mental equipment, initiative and independence of the university trained man, are they prepared to pay the price? A large majority of college graduates will enter industrial

Where There's a Will There's a Way

establishments this year at an initial salary of $125 a month. How will they be treated once they have entered the ranks? Despite the increasing number of college trained executives the railroads do not invariably have the reputation for pursuing a broad gage, fair-minded policy towards their technical employees. Is not the National Agreement too small a part of the whole big problem to be accepted as the determining factor?

The Weakest Link

The old adage that no chain is stronger than its weakest link applies with particular force to the present engine terminal situation. Bridges are constantly being rebuilt or reinforced to meet the requirements of heavier locomotives and heavier rails must precede heavier wheel loads; but larger, heavier and more complicated locomotives are being placed in service with no consideration for their effect on engine terminals until the situation at many terminals is well-nigh intolerable. How can large modern locomotives, equipped with many important auxiliary devices be handled in the average roundhouse or around the average terminal so that the potential capacity and efficiency of the equipment can be fully realized? Have not engine terminals generally reached the breaking point, making it unwise to increase the size of locomotives or add to the auxiliary equipment until these terminals are modernized? One of the best equipped railroads in this country has recently ruled against placing a single additional device on locomotives no matter how meritorius, for the reason that its engine terminal facilities are recognized as totally inadequate. Recognition of this state of affairs is commendable, but it is a situation that must be corrected or locomotive development will come to a standstill. When engine terminals have become inadequate to the upkeep of important auxiliary devices that are essential to economy and efficiency in locomotive operation, it is obviously a mistake to spend additional money on locomotives until the terminal situation, which may be said to constitute the weakest link in the chain, has been strengthened.

Heavy vs. Light Machine Tools

An important point always insisted upon by the late J. H. Manning, superintendent of motive power of the Delaware & Hudson, was the use of light machine tools for work requiring only light cutting operations. Mr. Manning maintained that whenever a heavy machine is used on light work there is not only an unnecessary waste of power, but a heavy, expensive machine is tied up on relatively light, unimportant work. For example, it used to be considered good practice to keep a big cylinder or frame planer busy on shoes and wedges in idle time. This practice has been proved uneconomical because the increased power consumption, depreciation and wear and tear on the machine, if charged to the shoes and wedges, would make them exceedingly expensive. It is not uncommon to find large planers and other large machines in shops where they occupy valuable floor space and yet stand idle for days at a time. Of course, at outlying points it is necessary to have machines of sufficient capacity to handle occasional large work, for when a cylinder or frame is wanted, it is wanted badly and the cost is not so important. There is a tendency, however, to play the game too safe and order machines for the largest work that will by any chance need to be handled. In this way a shop may be equipped with machines that will be too heavy for by far the largest proportion of the work to be done on them. Would it not be much better, by looking ahead a little, to ship the exceptionally large work away and spend the additional capital for short cut lathes, medium sized boring mills, turret lathes, drill presses, etc., thus increasing the facilities for performing the bulk of machine operations?

Why They Did It Electrically

The sphinx has spoken, and as we all suspected, it had something to say when it spoke. The sphinx in this particular instance is a composite animal and is made up of a body of men who have real information at hand concerning the electrification of steam railroads. The papers presented by representatives of ten railroads comprise the report of the Committee on Design, Maintenance and Operation of Electric Rolling Stock. These papers sum up the experience of the roads and include many interesting results of operation. They also give reasons for adopting electric traction. Some of these reasons are well known, such as tunnel and terminal conditions, city ordinances, congested traffic conditions, and possibly economy of operation, even where there is no congestion. Other reasons are not so well known. For example, it is pointed out by H. R. Warnock, general superintendent motive power, Chicago, Milwaukee & St. Paul, how the desire to develop a market for power, together with a variety of conditions and circumstances, led to the adoption of electric operation on the Butte, Anaconda & Pacific and the St. Paul. Figures on cost of operation are included relating to electric operation on the Butte, Anaconda & Pacific to show that its anticipated reduction in the cost of operation has been realized, while the quality of service has been improved. Many roads are now considering the advisability of adopting electric operation on certain sections and the report will be of great and real value to them. The men who contributed to the report should be highly commended, for only by such open policy and concerted action as theirs can rapid and intelligent progress be made in the field of railway electrification. Correlation of data and more cost data are needed, but the committee's work is a big step in the right direction.

Avoiding Discussion of A Vital Subject

The subject of labor conditions and problems has been conspicuously absent from the program of the Mechanical Section and from the discussions on the convention floor. On the other hand, labor conditions and problems on the railways have been the subject of more discussion than anything else on the part of railway men attending the conventions when they have met informally on the pier, on the boardwalk and in the hotels. The reason why there has been so much discussion of labor matters outside the convention hall is that the labor problem is the most vital and difficult problem with which the mechanical officers, as well as all other officers in the operating department of the railways, are now struggling. It is certainly remarkable that the foremost problem of current railroad operation should be receiving practically no organized study and discussion by railway officers. The mechanical officers are not open to much criticism for not tackling this problem in convention, because if they dealt with it frankly and openly in their meetings they probably would be subjected to severe criticism by the railway executives. One of the principal reasons, perhaps the principal one, why the labor problem has become so acute on the railways is that it has not been investigated, dis-

cussed, and dealt with with the courage, frankness and intelligence required. Instead of being constantly discussed in a corner as it is almost universally, the organizations of the railroad companies ought to be so changed as to enable them to deal in new and better ways with the labor problem and then the new methods adopted should be made the subject of reports, comparisons, discussion and co-operation between the various railroads in much the same way as new developments in the engineering branches of the business. When the railroad labor problem is made the subject of more scientific investigation, discussion and action and is treated less as a thing which must be whispered about in a corner, a beginning will be made in solving it, and no real beginning in solving it will be made until this is done.

Front End Design

THE conclusions of the Committee on Fuel Economy and Smoke Prevention are highly conservative, but are very definite on one point, i. e., that all preconceived ideas of exhaust jet action must be revised. In pointing out the need for a long series of test plant observations to determine the most efficient form of exhaust nozzle, the committee has gone even further and included the whole subject of front end design. No subject involving the proportioning of locomotives is in more need of experimental investigations for the purpose of developing fundamental laws of general application. In this day of large locomotives and high fuel cost, anything which will increase the capacity without increasing the size of the locomotive, or will increase the ton miles per hour or per pound of coal, should receive the earnest attention of every motive power department officer. The possibilities in these respects from improved draft appliances were clearly brought out by H. B. McFarland, engineer of tests of the Atchison, Topeka & Santa Fe, in tests, which showed the enormous amount of power required to draft the locomotive with the customary type of exhaust nozzle and front end arrangement.

That a great improvement is possible without radical change in the design of the locomotive as a whole was clearly demonstrated by the Norfolk & Western tests, a report of which was published in the Railway Mechanical Engineer in June, July and August, 1918. By a change in the shape of the exhaust nozzle and an increase in the diameter of the stack, the same draft was produced with approximately 4½ lb. cylinder back pressure which required slightly less than 11 lb. back pressure with the circular nozzzle. The theory on which this development was based is that the greatest effect in the movement of front end gases is produced by the entraining action of the jet surface exposed to the surrounding gases. If this theory is correct, it is obvious that the greatest draft which can be obtained from a given volume of exhaust steam will be produced by a form of jet having the largest practical ratio of periphery to cross-section area. Unsupported theories are of little practical value.

It should be pointed out in this connection, however, that such attempts as have been made toward increasing the draft efficiency have supported this theory and such data are sufficiently numerous to justify an investigation accepting it as a working basis in order that, if it proves to be correct, its limitations may be determined before investigations along other lines are attempted. But the shape of the exhaust nozzle should be taken up in relation to other features of the front end which have to do with the control and distribution of the draft on the fire. The possibilities for increasing locomotive economy and capacity make this a fertile field for test plant investigations.

Program For To-day

SECTION III—MECHANICAL

9.30 A. M. TO 12.30 P. M.

Discussion of Reports on:	
Locomotive Headlights and Classification Lamps	9.30 A. M. to 10.00 A. M.
Feed-Water Heaters for Locomotives	10.00 A. M. to 10.30 A. M.
Individual Paper on "Locomotives as a Big Investment," by George M. Basford	10.30 A. M. to 11.00 A. M.
Discussion of Reports on:	
Design and Maintenance of Locomotive Boilers	11.00 A. M. to 11.30 A. M.
Engine Terminals, Design and Operation	11.30 A. M. to 12.00 M.
Train Resistance and Tonnage Rating	12.00 M. to 12.30 P. M.

ENTERTAINMENT

10.30 A. M.—Orchestral Concert, Entrance Hall, Million Dollar Pier.

3.30 P. M.—Orchestral Concert and Impromptu Dancing, Entrance Hall, Million Dollar Pier.

4.30 P. M.—Tea will be served in Entrance Hall.

9.00 P. M.—Carnival Night with Special Features, Ball Room, Million Dollar Pier.

Lost Badges

No. 5629. E. A. Emery, Gustin-Bacon Manufacturing Company.

No. 5604. J. T. Miller, Standard Car Truck Company.

No. 5334. A. L. Schuhl, Independent Pneumatic Tool Company.

Purdue Dinner

THE PURDUE MEN and their wives are planning their dinner for Saturday night, the place to be announced later. Please sign up promptly with Charlie Bird at the Bird Archer exhibit. A regular old time is promised by Prof. L. E. Endsley, B. B. Milner, engineer motive power, N. Y. C., and R. B. Watson, engineer of tests of the Erie.

The Track Exhibit—A Correction

THE NEW YORK CENTRAL LOCOMOTIVE equipped with the trailer tractive effort booster, which was incorrectly stated to be at the Pennsylvania electric station, in yesterday's issue, is actually located on the Pennsylvania tracks at Georgia Avenue and the Boardwalk. The locomotive is under steam and the trailer booster may be seen in actual operation.

Bulletins From the Republican Convention

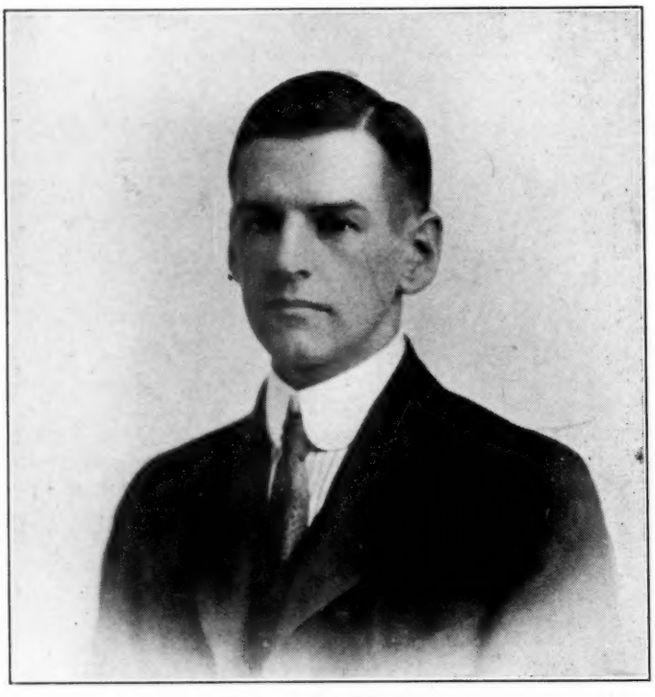
THOSE OF OUR GUESTS who have placed bets on the Republican nomination for President of the United States and others, can ease their minds by watching the *Railway Age* bulletins which will be posted on the mirrored post in its booth near the entrance to the hall.

These bulletins will be kept up to the minute and will announce the important turns in this portentous event until the nominations are secured.

Railway Age European Editor On Visit to the United States

ROBERT E. THAYER, who in April, 1919, was transferred from New York to London as European editor of the *Railway Age* and other Simmons-Boardman publications, is making his first visit to the United States since he went abroad. He arrived in New York on Tuesday and came to Atlantic City on Wednesday to attend the conventions. Mr. Thayer is well known to many of the convention visitors, having been before he went abroad mechanical department editor of the *Railway Age* and managing editor of the *Railway Mechanical Engineer*. He will return to London about August 1.

During the more than a year that Mr. Thayer has been abroad he has had many interesting experiences and has had an extraordinarily good opportunity to study railroad, industrial and business conditions abroad.



Robert E. Thayer
European Editor of the Railway Age

While his headquarters are in London, he has traveled extensively on the continent. In May, 1919, a month after he arrived in London, he went to France and from there to Belgium, where he made a thorough study of the conditions on the Belgian lines. He then returned to England, where he stayed during July, August and September. He was on a trip to Scotland when the general strike on the British railways occurred and had to stay there a week, although he returned to London on the first through train that was run down from Scotland. Many of our readers will remember the interesting and comprehensive article Mr. Thayer wrote for the *Railway Age* regarding the British railway strike.

In January Mr. Thayer went to Switzerland and traveled over the lines now being electrified from Erstfeld to Bellinzona. This is a part of the St. Gothard line to Italy. While on the trip Mr. Thayer visited the subterranean station in the Simplon tunnel, which is 6,500 ft. underground.

He returned to London in the latter part of January and about the middle of February left for a trip to Holland and Germany. While in Germany he traveled extensively over the railways of that country, visiting Bremen, Hanover, Berlin, Dusseldorf, Essen, Cologne, Weisbaden, which is the headquarters of the Inter-Allied Railway Commission, and Heidelberg, returning to London about the middle of March.

Mr. Thayer was sent to Europe in order that the readers of the *Railway Age* and other publications of the Simmons-Boardman Company might be kept informed by a man familiar with American railway conditions and practice, of the railway conditions and practice in Europe, and of the conditions affecting the market for American railway equipment and supplies abroad. In order that he may carry on his editorial work efficiently it is necessary that he should keep closely in touch with conditions in the United States and he returned to this country so as to be here at the time of the conventions, because it was felt that it was essential to the continued success of his work that he should not even temporarily get out of touch with conditions in the railway and railway supply industries in the United States.

Appliances Association Officers Here

A NUMBER OF THE OFFICERS AND DIRECTORS of the National Railway Appliances Association are attending the conventions and studying the exhibits. The National Railway Appliances Association is the organization of the railway supply interests which give the exhibit at the Coliseum in Chicago each March in connection with the convention of the American Railway Engineering Association.

Among the officers and directors of this organization who are here are J. B. Strong of the Ramapo Iron Works, who is president of the association; D. W. Kelly of the Kelly-Derby Company, who is secretary-treasurer; and A. A. Taylor, of Fairbanks, Morse & Co.; George C. Isbester of the American Chain Company, and H. A. Filkins, of Paul Dickinson, Inc., all of whom are directors. An informal conference of these officers of the Railway Appliances Association was held at the Traymore yesterday.

The exhibits given in connection with the mechanical convention at Atlantic City in June and in connection with the engineering convention at Chicago in March are very much the largest exhibits of railway equipment and materials made anywhere in the world. Many railway supply companies make exhibits at both conventions. The officers of the National Railway Appliances Association feel, and undoubtedly rightly so, that study of each others methods and exhibits by the officers of their association and of the Railway Supply Manufacturers' Association, and closer co-operation between these two organizations will improve the exhibits both in Atlantic City and Chicago and thereby be helpful to both the railway and the railway supply industries.

Mr. Kelly announces that it will be possible to make the exhibit at Chicago larger than ever next March, as several thousand additional feet of space have been obtained in the Coliseum and the Coliseum annex in which the exhibits are given.

Transportation Home

THE REPRESENTATIVES OF THE Pennsylvania Railroad Company would like to have some knowledge of what day the members will leave, and what trains they will leave on. Kindly give Secretary Hawthorne a memorandum of the train you would like to go on, and the date, and the accommodations you will require. It will aid the company in deciding the amount of Pullman equipment to be used for that purpose.

American Railroad Association—Section III—Mechanical

Report on Safety Connections Between Engine and Tender Provokes Lively Discussion

Chairman Tollerton called the meeting to order on Thursday morning at 9.45 A. M.

Report on Fuel Economy and Smoke Prevention

IN ITS REPORT OF 1919 the committee emphasized the growing importance of fuel economy to the railroads, arising from increasing consumption and increasing cost of production. Both of these factors are likely to result in the largest fuel bills in railroad history during the present year. It is certain that there will be substantial increases in the cost of production and only the application of prompt and effective means will prevent an increased consumption out of proportion to any probable expansion in traffic. It is therefore, urged that every railroad check its current consumption with previous records with a view to the adoption of such measures as the situation may require.

Fuel Economy on Locomotives

With the return of the railroads to corporate control and operation, the Fuel Conservation Section ceased to exist. The work of this important branch of the Railroad Administration was of unquestioned value in promoting economy in the purchase, distribution and use of fuel for railroad purposes. The methods employed were substantially those advocated by the committee in previous reports and they must have continued intensive application if the cost of fuel is not to exceed even its present ratio to total operating expense.

The publication of the Fuel Conservation Section no longer bears an official status and may, therefore, fail to serve their most useful purpose unless incorporated in the official publications of the American Railroad Association. This is particularly true of the pamphlet on "The Economical Use of Railroad Fuel" most recently issued. While this incorporates many features contained in the present official publication of this Association issued under the title of "Fuel Economy on Locomotives," there is some additional material gathered as a result of greater experience in the application of the principles of fuel economy to locomotive operation as well as some subject matter not treated in the Association pamphlet, that it is believed should be incorporated and accordingly a revision of the text of Fuel Economy on Locomotives, is submitted with the recommendation that suitable action be taken to place it before the General Committee for adoption as standard practice.

[The original text of Fuel Economy on Locomotives was incorporated in the 1915 report of the committee. Some additional matter has been included in the revised text, on subjects included in the original, but the principal change is the addition of instructions relating to burning anthracite and mixed anthracite and bituminous coal, oil burning practice, stokers, draft appliances, and a number of sections dealing with locomotive maintenance.—EDITOR.]

Exhaust Nozzles

The committee was instructed to investigate the shape of exhaust nozzles to determine that which would produce the highest vacuum and least back pressure.

This is a problem requiring for its solution the preservation of practically uniform conditions throughout the investigation and, therefore, one demanding a series of test plant observations. While it may be possible to obtain rough approximations in tests under road conditions, the variables are so numerous and so great as to impair the value of conclusions demanding a reasonable degree of accuracy. Variations affecting the results by as much as five per cent would be fatal to an investigation in which such a variation is of as much importance as it is where both hauling capacity and fuel economy are involved. The facilities for the required investigation are not now at the service of the association, but through the courtesy of the Pennsylvania Railroad a partial report may be made from tests conducted in the Altoona test plant.

The investigations made by the Pennsylvania were for the

purpose of ascertaining the maximum equivalent evaporation and the least average back pressure under uniform operating conditions with different shape nozzles.

Description of Nozzles

Circular Nozzle.—This nozzle gradually tapers to the exit diameter at a distance of one inch from the exit, the sides being parallel beyond this point.

Rectangular Nozzle.—The nozzle has a circular entrance, gradually tapering into a rectangle at a distance of 2⅜ in. from the inlet. From this point the sides of the opening are parallel for a distance of one inch to the tip of the nozzle.

Four Internal Projection.—This is a circular nozzle having triangular shaped bars projecting one inch toward the center from four equal distant points on the edge of the nozzle. The bars have an edge turned toward the discharge jet.

Alligator Nozzle 12 in. High.—This is a circular nozzle having two jaws or points projecting 12 in. above the tip of the nozzle. The jaws are 6¼ in. apart at the tip, and this diameter remains constant to a point ¾ in. below the tip of the nozzle, from which point the diameter is gradually increased to the nominal dimension.

Alligator Nozzle 6 in. High.—This is similar to the 12-in. alligator nozzle already described, except that the jaws are 6 in. high.

Four Vertical Projection.—This differs from the alligator nozzle in that it has four points instead of two. The diameter is uniform to a point 1 in. below the tip of the nozzle, from which point it gradually increases to the nominal diameter at the bottom.

Vertical Projection and Splitter.—This is circular, a splitter being fitted at the top, and a conical piece attached to the splitter at the center, projecting downward 6½ in. below the tip of the nozzle.

Special Shaped Nozzle.—This consists of a circular nozzle having four projections from the tip 4 in. high, which are bored conical, the diameter at the top being ¾ in. smaller than at the bottom of the projections. These projections are 2 in. wide at the bottom and flare out to about 4 in. in width at the top.

Splitter.—This consists of a circular nozzle, across the center of which is fitted a triangular piece having one edge directed downward toward the discharge jet and having a width of ⅜ in. at the top.

Four Notched Circular.—This nozzle has four notches set into it at the top.

Summary of Results of Nozzle Tests

Description	Dry coal per hour	Equivalent evap. per hour	Average least back pressure	Rank
Four internal projections	9,421	65,129	14.9	1
Rectangular	9,810	64,316	14.3	2
Circular, area 33.29 sq. in.	4,218	49,249	9.2	6
Circular, area 30.68 sq. in.	6,734	52,223	10.5	5
Alligator, 12 in. high	5,292	47,852	9.6	11
Alligator, 6 in. high	6,186	49,129	11.2	9
Four vertical projections	5,833	50,773	8.	6
Vertical projection and splitter	7,048	59,624	10.8	5
Four notched circular	5,003	50,833	8.1	7
Splitter	7,304	58,586	10.9	4
Special shape	5,854	47,890	5.8	10

Method of Test

These tests were made on a Pacific type locomotive equipped with a superheater and a brick arch. The same arrangement of front end details was maintained throughout the tests. With each design of nozzle, the evaporative rate was increased until the boiler limit was reached, the usual observations being taken of boiler and engine performance.

Result of Tests

The results of the tests corresponding to the various shapes of nozzles are shown in the accompanying table. They indicate that under the conditions peculiar to this test with a nozzle having four internal projections it was possible to obtain a higher equivalent evaporation per hour with less back pressure than with a circular or rectangular nozzle having approximately the same net area.

Conclusions

The committee does not consider the information now available sufficiently complete to justify positive conclusions as to the most efficient shape of nozzle, and is only in position to report that the circular form of nozzle does not result in the highest vacuum and the least back pressure. What form will produce these conditions it is impossible to say without an extended investigation involving a long series of test plant observations.

It seems evident, however, that all preconceived ideas of exhausted jet action must be revised to agree with the apparent fact that the best results will be obtained when the jet contour is interrupted as is the case both with the internal projection nozzle and with the one having one axis longer than the other.

Front End Design

Your committee has given some consideration to the matter of front end appliances as affecting fuel economy and locomotive repair costs, but is unable to present a design applicable to all types of locomotives in different classes of service. In fact, a suitable general standard would not meet practical requirements, because of the variables introduced through differences in dimensions vitally affecting the problem. The best arrangement should be determined for each class of locomotive and normal service conditions using the regular fuel supply.

There is, however, opportunity for increased facility in maintenance and reduced cost of repairs through the use of the so-called "unit" front end netting arrangement. It is obvious that a design permitting the complete removal of the assembled netting will be more easily maintained, will reduce locomotive shop hours, and effect a reduction in the cost both of labor and material. For these reasons, it is the opinion of the committee that the use of some form of unit front end should be extended.

A suitable standard having been determined, the front end details should be permanently fastened to prevent further adjustments. The only variable in the front end should be the exhaust nozzle and this should never be altered to cure a steam complaint until the cause of the complaint has been determined.

Running Stoker Engines Over More Than One Division

The committee recognizes that there may be some fuel economy in running stoker-fired locomotives over more than one division, but does not find that the practice prevails.

While it may be practicable to increase the mileage of such locomotives, the net economy of operation is doubtful, especially as topographical conditions are frequently such that it is impossible to handle the most economical rating on the second division, the loss in fuel per thousand ton miles therefore exceeding the saving otherwise effected. This is a question that must be determined by local operating conditions, including terminal facilities.

The report was signed by Wm. Schlafge (Chairman), Erie; W. H. Flynn, Michigan Central; Robt. Quayle, Chicago & North-Western; D. J. Redding, Pittsburgh & Lake Erie; W. J. Tollerton, Chicago, Rock Island & Pacific; C. H. Hogan, New York Central, and F. P. Roesch, Standard Stoker Company.

Discussion

In presenting the report, Wm. Schlafge (Erie), Chairman of the committee, stated that it was "a general rehash of the subject dating back to the time of the appointment of the committee."

John A. Pilcher (N. & W.): The arrangement of the nozzles described in a series of articles commencing in the *Railway Mechanical Engineer* of June, 1918, was based on a series of experiments conducted on the Norfolk & Western, something like two years ago. The tests were conducted on a large Mountain type locomotive, in which a special form of nozzle, described in these articles, was used.

The conception of this nozzle was due to the fact that the engine choked itself from back pressure, and we could not get the speed out of it. The first thought was that if it was possible to enlarge the stack and still keep up the necessary vacuum in the smokebox to furnish the necessary draft, we would be able to reduce the back pressure.

A number of experiments were carried out, I think there

were something like 70 or 75 special trains operated simply for the purpose of developing this nozzle. We were able to increase the size of the stack from 19 in. to, I think, 26 in.

When we started out we had the engine running about 35 miles an hour on pretty heavy load, and about 11 lb. back pressure, and approximately 8 in. vacuum in smokebox. When we wound up we had something like 8 lb. of back pressure and 4 in. of vacuum in the smokebox.

We practically remade the engine. I would like to know if the committee had noticed this publication in the *Railway Mechanical Engineer,* which gave a full description of the whole test.

To give an idea of what we did to the engine, when traveling at a speed of 50 miles an hour, a drop of 7 lb. in the back pressure was equivalent to the addition of 300 HP.

B. B. Milner (N. Y. C.): The New York Central ran some extensive nozzle tests about two years ago upon all shapes and sizes and kinds of nozzles, and in connection with these tests developed a form of exhaust nozzle which would give the results to which the previous speaker has just referred; that is, a nozzle which would give the necessary draft and very greatly enlarge the opening.

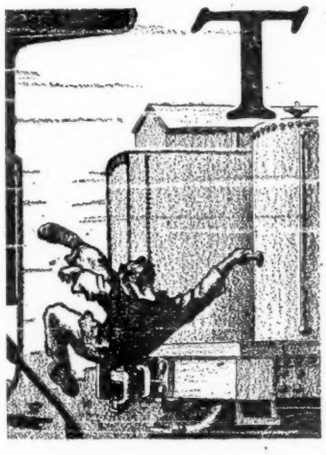
I do not know anything about the details of the Norfolk & Western design of nozzle, but the nozzle which was developed on the New York Central Lines, as the result of the experiments referred to, consists of a ring which is broken in about five or six places, so that there are about five or six streams of exhaust steam, and the smokebox gases, instead of being entrained in the exhaust jet of the circular nozzle on the outside of the stream only, are entrained in between the several streams.

No conclusive dynamometer tests have been run on engines operating these nozzles recently, in order to develop and determine the differences in the horsepower and drawbar pull, which may be developed, particularly at the higher speeds, where the increased nozzle area will be most effective, but some 8 or 10 engines have been running for a year and a half with nozzle openings about 35 per cent. greater than the nozzle opening of sister engines, running with the plain circular nozzle.

Chairman Tollerton: *A motion will be in order that the report be accepted, and such portions of it as may be necessary be referred to letter ballot.*

Such a motion was made and unanimously carried.

Safety Connections Between Engine and Tender



THE PRINCIPAL FEATURES in the safety of connections between engine and tender are: (1) A drawbar of sufficient strength to stand the pull of the locomotive and of sufficient additional strength to stand unusual shocks which suddenly increase the stress for short periods; (2) proper proportion of metal to make the strength of the bar practically the same throughout; (3) pins of proper strength to withstand the same load as drawbar and large enough, within practical limits, to reduce wear to a minimum; (4) draw castings on the engine and tender of equal or greater strength than the drawbar and secured to the engine and tender so firmly that any failure will be in the pin or the drawbar and not in the engine or tender; (5) additional draw connections between the engine and tender of such strength that in case of failure of the drawbar or pin, the safety connections will hold engine and tender against separation so that an apron of reasonable width will not fall between the engine and tender or permit any one standing on deck to fall through; (6) material in drawbar and safety connection of such quality that it will stand frequent shocks, vibrations and blows without rapid crystallization—a material that is tough without necessarily being of high tensile strength; (7) pocket in draw castings of such dimensions that there will be minimum tendency to bend the pin but sufficient space to permit the required vertical movement of the drawbar without binding.

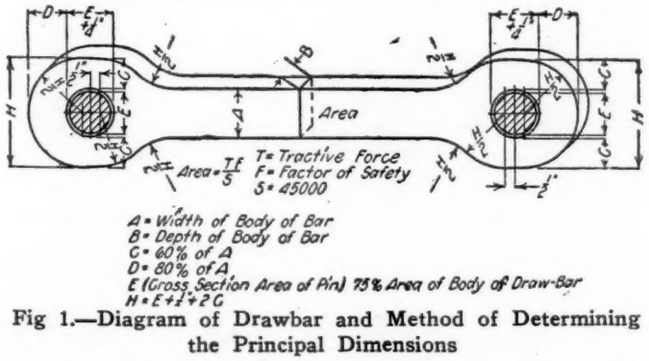

Area
Area = TF/S
T = Tractive Force
F = Factor of Safety
S = 45000
A = Width of Body of Bar
B = Depth of Body of Bar
C = 60% of A
D = 80% of A
E (Gross Section Area of Pin) 75% Area of Body of Draw-Bar
H = E + 1 + 2C

Fig 1.—Diagram of Drawbar and Method of Determining the Principal Dimensions

Design of Drawbars

Drawbars should be straight throughout their full length. Drawbars should be of such size and area that working stress based on the normal tractive effort of the locomotive should not exceed 4500 lb. per sq. in. and the factor of safety should be not less than 10. Some roads require a minimum factor of safety of 15 and others require a factor still higher. Where a central safety bar is used the same limit of stress and safety factor as in the drawbar should be required.

The following are simple formulæ for designing drawbars and pins:

$$\text{Area through body of bar} = \frac{TF}{S}$$

T = Tractive force.
F = Factor of safety — minimum, 10.
S = 45,000 = Tensile strength of wrought iron, per sq. in.
Area of each drawbar pin or safety-bar pin = 75 per cent of area through body of bar.

The area of the pin is based on the cross-section of a straight bar without bends or offsets and with depth of pocket not more than one inch greater than the thickness of the drawbar. An offset or bent bar must be of greater cross-section than a straight bar and it is not necessary to increase the size of pin accordingly.

A diagram of a satisfactory general form of drawbar, together with method of determining principal dimensions, is shown in Fig. 1. Tables of dimensions of drawbars for different tractive efforts, at factors of safety of 10, 15 and 20, are shown in Fig. 2. These tables are based on a tensile strength of 45,000 lb. per sq. in. for the higher tractive effort shown on each line.

It is recommended that the material in drawbars, safety bars, safety chains and in drawbar, safety-bar and safety-chain pins shall be of refined wrought iron of good grade, having an ultimate tensile strength of not less than 45,000 lb. per sq. in. The use of steel in any of these parts is not recommended.

Safety Bars and Safety Chains

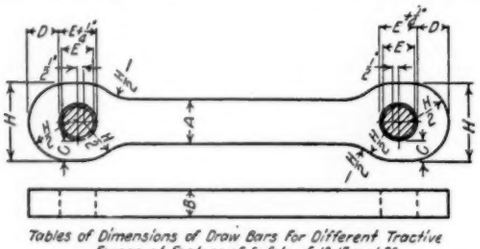
It is the opinion of the committee that all new locomotives should be built with a central safety bar located immediately beneath the drawbar. Where construction of the locomotive and tender prevents this application two safety bars should be applied, one located on each side of the drawbar and as near thereto as possible. In building new locomotives, every effort possible should be made to design surrounding parts to permit the application of a central safety bar.

Safety bars are more satisfactory than safety chains for locomotives of 45,000 lb. tractive force or over. The limit

of 45,000 lb. is proposed for the reason that chains within the limit of the prescribed stress would have to be of such size as to be impracticable and inconvenient in handling and maintaining. When locomotives of 45,000 lb. tractive force or over require new rear deck or foot plate castings, it is recommended to arrange the drawbar equipment on both the locomotive and tender to apply safety bars, using the central safety bar preferably.

Where two safety bars are used, they should be located as near as practical to the drawbar to reduce to a minimum the amount of slack required in the pin hole to permit the locomotive taking curves satisfactorily.

Where two safety bars are used, they should be of such size



Tables of Dimensions of Draw Bars for Different Tractive Forces at Factors of Safety of 10, 15 and 20

TRACTIVE FORCE	FIBRE STRESS 4500# FACTOR SAFETY 10						FIBRE STRESS 3000# FACTOR SAFETY 15						FIBRE STRESS 2250# FACTOR SAFETY 20					
	A	B	C	D	E	H	A	B	C	D	E	H	A	B	C	D	E	H
10,000 to 20,000	3	1 1/2	2	2 1/2	2 1/2	6 3/4	3 1/2	2	2 1/8	2 7/8	2 3/4	7 1/4	3 1/2	2 1/2	2 1/4	3	3	7 3/4
Over 20,000 to 30,000	3 1/2	2	2 1/4	3	3	7 3/4	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2	4 1/2	3	2 3/8	3 3/8	4	9 3/8
Over 30,000 to 45,000	4	2 1/2	2 1/2	3 1/4	3 1/2	8 3/4	5	3	3	4	4	10 1/4	6	4	3	4	4 1/2	10 3/4
Over 45,000 to 65,000	5	3	3	4	4	10 1/4	5 1/2	4	3 3/8	4 1/2	4 3/4	11 3/4	6 1/2	4 1/2	4	5 1/4	5 1/4	13 1/2
Over 65,000 to 85,000	5 1/2	3 1/2	3 1/2	4 1/2	4 1/2	11 3/4	6 1/2	4 1/2	4	5 1/4	5 1/4	13 1/2	7 1/2	5	4 1/2	6	6	15 1/4
Over 85,000 to 110,000	6 1/2	4	4	5 1/4	5	13 1/4	7 1/2	5	4 1/2	6	6	15 1/4	9	5 1/2	5 1/2	7 1/4	7	18 1/4
Over 110,000 to 135,000	7	4 1/2	4 1/2	5 3/4	5 1/2	14 1/4	8 1/2	5 1/2	5 1/8	6 3/4	6 3/4	17 1/4	9	6 1/2	5 1/2	7 1/4	7 1/2	18 3/4

Fig 2.—Tables of Dimensions of Drawbars for Different Tractive Efforts, at Factors of Safety of 10, 15 and 20

and area that the working stress based on the normal tractive effort of the locomotive does not exceed 4,500 lb. per sq. in. in both bars considered together and the factor of safety should not be less than 10. Safety bars should be free from bends and offsets. A diagram of a satisfactory general form of safety bar located at the side of the drawbar, together with method of determining the principal dimensions, is shown in Fig. 3. Tables of dimensions of safety bars for different tractive efforts, at factors of safety of 10, 15 and 20, are shown in Fig. 4. These tables are based on a tensile strength of 45,000 lb. per sq. in. for the higher tractive force shown on each line.

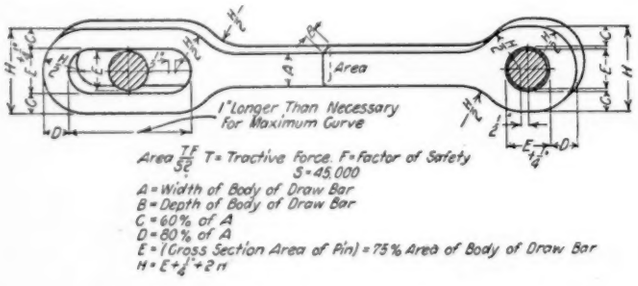

Area
1" Longer Than Necessary for Maximum Curve
Area $\frac{TF}{5C}$ T = Tractive Force. F = Factor of Safety
S = 45,000
A = Width of Body of Draw Bar
B = Depth of Body of Draw Bar
C = 60% of A
D = 80% of A
E = (Cross Section Area of Pin) = 75% Area of Body of Draw Bar
H = E + 1" + 2 H

Fig 3.—Diagram of Safety Bar (at Side of Drawbar) and Method of Determining the Principal Dimensions

Safety chains, where used, should be of such area that the working stress, based on the normal tractive effort of the locomotive should not exceed 4,500 lb. per sq. in. in both chains considered together and the factor of safety should not be less than 10. All bolts in safety chain connections should have double nuts and split key or cotter key where it is possible to apply them. Where space is limited, a single nut and split key or cotter key should be applied. It is not recommended that cotter key or split key alone be used. Clevises, clevis pins and attachments must be of strength equal to the chain.

The following is a simple formula for determining size of link in safety chains:

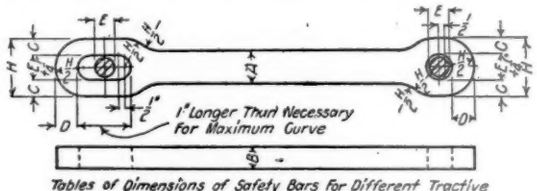
$$A = \frac{TF}{.75S4}$$

A = Area of bar of which link is made.
T = Tractive force.
F = Factor of safety — minimum, 10.
S = 45,000 = Tensile strength of wrought iron per sq. in.

Draw castings on locomotive and tender should be inspected at each regular drawbar inspection. At each locomotive general shopping, the draw casting on the locomotive should be given as thorough inspection as possible without taking down the casting and a similar inspection should be made on the tender. In addition, a thorough inspection should be made of all framing and bracing at the front of the tenders, as well as of all rivets and bolts. Where the sills, corner angles, braces, etc., are found corroded to the extent of impairing their strength, cracked or otherwise defective, these parts should be reinforced or renewed. Bolts which may be found under size should be replaced by bolts of original size.

Substitution of Safety Bars for Safety Chains

Where safety bars, one on each side of the drawbar, are of ample size without offset and have the proper arrangement of holes to give the required clearance without causing compression in either bar at any time, and where connections on the locomotive and tender are as strong as a drawbar of the required size, the cost incident to changing to a central safety bar is not considered to be justified. The committee investigated the application of additional brackets or built up ar-



Tables of Dimensions of Safety Bars for Different Tractive Forces at Factors of Safety of 10, 15 and 20

TRACTIVE FORCE	FIBRE STRESS 4500# FACTOR SAFETY 10						FIBRE STRESS 3000# FACTOR SAFETY 15						FIBRE STRESS 2250# FACTOR SAFETY 20					
	A	B	C	D	E	H	A	B	C	D	E	H	A	B	C	D	E	H
10,000 to 20,000	2	1 1/8	1 1/4	1 5/8	1 1/2	4 1/4	2 1/2	1 1/2	1 1/2	2	2	5 1/4	3	1 1/2	1 7/8	2 1/2	2 1/4	6 1/4
Over 20,000 to 30,000	2 1/2	1 1/8	1 1/2	2	2	5 1/4	3	1 3/4	1 7/8	2 1/2	2 1/4	6 1/4	3 1/2	2	2 1/8	2 7/8	2 3/4	7 1/4
Over 30,000 to 45,000	3	1 1/2	1 7/8	2 1/2	2 1/4	6 1/4	3 1/2	2 1/4	2 1/4	2 7/8	2 3/4	7 1/4	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2
Over 45,000 to 65,000	3 1/2	2	2 1/8	2 7/8	2 3/4	7 1/4	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2	4 1/2	3 1/4	2 3/4	3 5/8	3 3/4	9 1/2
Over 65,000 to 85,000	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2	4 1/2	3 1/4	2 3/4	3 3/4	3 3/4	9 1/2	5	3 1/2	3	4	4 1/2	10 1/2
Over 85,000 to 110,000	4 1/2	2 3/4	2 3/4	3 5/8	3 1/2	9 1/4	5 1/2	3 5/8	3 1/2	4 1/2	4 1/2	11	6	4	3 1/2	4 7/8	4 7/8	12 5/8
Over 110,000 to 135,000	5	3	3	4	3 3/4	10	6	3 3/4	3 3/8	4 7/8	4 3/4	12 1/4	7 1/2	4	4 1/2	6	5 3/8	14 3/8

Fig 4.—Tables of Dimensions of Safety Bars (at Side of Drawbar) for Different Tractive Efforts, at Factors of 10, 15 and 20

rangements to present locomotive and tender draw equipment by which to change from safety chains to central safety bars without discontinuing present draw castings on the engine and tender. This investigation was made on locomotives of various classes on several different railroads. In some few cases it is possible to add brackets or build up draw equipment on either locomotive or tender by which central safety bar can be applied. Practically in no cases coming within the observation of the committee is it possible to add a bracket or build up equipment on both the locomotive and tender by which to obtain an arrangement of sufficient strength to justify applying a central safety bar. In most cases where possible to build up on present equipment, it is necessary to incur the expense of taking down of present castings and machining them so that additional brackets can be bolted on satisfactorily, which expense is frequently nearly as great as applying new castings. With few exceptions it is more practicable to apply new draw castings to both locomotive and tender in order to obtain a safe and reliable arrangement where conditions justify changing to a central safety bar on locomotives in service.

The investigation of the committee demonstrates very clearly that the matter of bolting must be given great care where additional brackets or built-up equipment are applied and that

the strength of the bolts and the equipment bolted on must be strong enough to stand any stresses to which the safety bar might be subjected. It is not sufficient to bolt on a makeshift arrangement that has the appearance of holding the safety bar. The equipment applied must be strong and well supported as this equipment is applied as a safeguard for human lives.

The process of welding should not be permitted in applying supplementary brackets or equipment to facilitate the application of a central safety bar. The element of uncertainty as to the possible strength of welds condemns this process in connection with parts on which so much depends in the matter of safety.

COST OF CHANGING TO CENTRAL SAFETY BARS ON LOCOMOTIVES IN SERVICE

Approximate figures based on 1920 prices for labor and material, including surcharge, for equipment applicable to large locomotives of Pacific, Mikado or Santa Fe type.

New Equipment on Locomotive and Tender	
New draw casting or deck in rough, for locomotive	$235.00
New drawbar, safety bar, pin, bolts, finished	72.00
Machining deck, removing old deck, applying new deck	64.00
Equipment on locomotive, drawbar and safety bar	$371.00
New tender draw casting in rough for tender	$145.00
Pin, pin carrier, rivets	18.00
Machining tender draw casting, removing old casting and applying new	30.00
	$193.00
Total for new equipment on engine and tender, including new bars	$564.00
Modification of Both Locomotive and Tender Equipment	
Locomotive equipment and safety bar	$107.00
Tender equipment	64.00
	$171.00
Modification of Locomotive Equipment and Application of New Tender Equipment	
Locomotive equipment and safety bar	$107.00
New tender equipment	193.00
	$300.00
New Locomotive Equipment and Modification of Tender Equipment	
New locomotive equipment, drawbar and safety bar	$371.00
Tender equipment	64.00
	$435.00

The figures given in the table are approximate estimates and will vary with different conditions and different construction. They do not include any royalty, and where a patented device is applied the price of the royalty must be added in each case. While the estimates are given of the approximate costs of different combinations of applications, investigation indicates that in most cases the application of central safety bars to locomotives already in service will involve new draw castings on engine and on tender, as well as new bars and incidental changes. With payment of a royalty, the total cost of the change will often be approximately $600 per locomotive.

Offset Drawbars

In designing and constructing drawbars for new locomotives, they should be made without bends or offsets. The use of offset bars should be eliminated as far as possible on the locomotives already in service.

Before bending or offsetting a bar the matter should be submitted to an authorized office and the stresses estimated

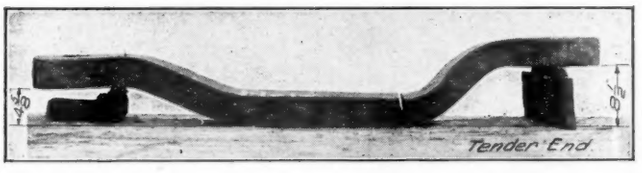


Fig 5.—Broken Drawbar With a Bad Offset.

before the bar is allowed in service. If drawbars are to be safe, the careless practice of offsetting drawbars for convenience in quick exchange of tenders must not be permitted.

The danger from offset drawbars justifies illustrating an example of a badly offset drawbar removed from service because of breakage. A photograph of this drawbar is shown by Fig. 5 and the following facts illustrate the effect of offset:

Locomotive tractive effort	35,000 lb.
Fiber stress per sq. in. in straight drawbar of same cross-section	1,984 lb.
Factor of safety in straight drawbar of same cross-section	22
Fiber stress per sq. in. in offset bar shown by Fig. 5	26,632 lb.
Factor of safety in the offset bar	1.4

Drawbar and Safety-Bar Pins

With central safety bars, it is permissible to use separate pins for the drawbar and for the safety bar.

Where surrounding conditions permit, it is best practice to apply draw pins from above, forming the pin with a head at the upper end and applying a split key or cotter key through the lower end of the pin to prevent its working up. Where the pin cannot be applied from above, it is satisfactory to apply it from below, but it must be securely supported. A satisfactory method of supporting pins applied from below is shown by Fig. 6.

Manufacture and Repairs

Drawbars and safety bars are not to be welded in manufacture or repairs. Each bar is to be forged in one piece. It is recommended that pin-holes in drawbars and safety bars be

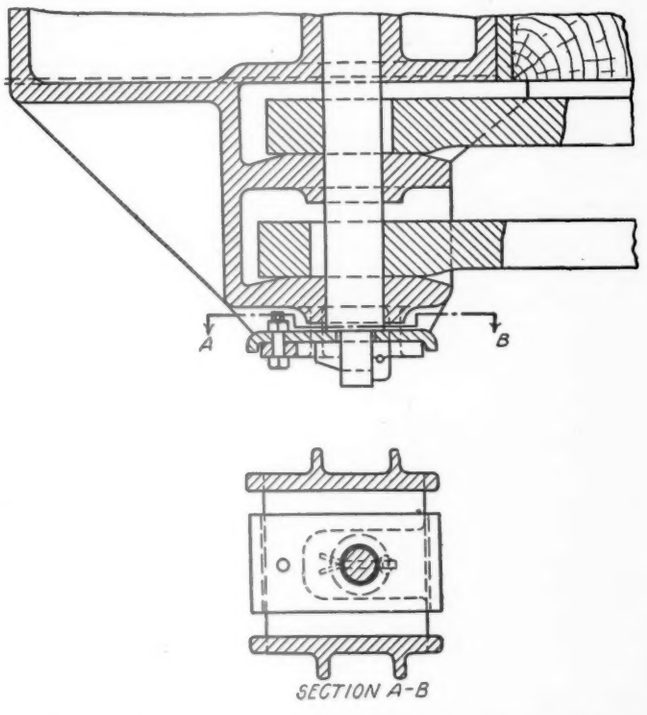


Fig 6.—Method of Securing Drawbar Pins Applied From Below

drilled when the bars are cold, and under no circumstances are they to be punched.

When drawbars are made new and when they are heated for forging or upsetting, they are to be cooled slowly. Under no circumstances are they to be quenched in water. Drawbars in service shall be thoroughly annealed at least every six months and closely inspected for defects after being annealed. Inspection at time of annealing shall serve as one of the required quarterly Federal inspections. The same practice is to be followed with safety bars, safety chains and pins.

In order that each drawbar shall carry a record of date of application, as well as date of inspection and annealing, a simple practice of marking with steel stencils is recommended. Stencil the date and place of application on the top face of the drawbar near the tender end. Keep this stenciling legible until drawbar is scrapped. Stencil the date and place of last inspection or annealing on the right side of the drawbar midway between the ends. Obliterate the previous marks in this location before restenciling. No other marks should be allowed to appear on the drawbar. To indicate the class of work, the letter *I* should be stenciled after the date when inspection only

is made, the letter *A* when annealed and the letter *N* when a new bar is applied. As a matter of record, it may be desirable to arrange for the initial of shop applying the drawbar to precede the date.

Drawbar and Safety Bar Pockets

Drawbar and safety-bar pockets should be at least as strong as the drawbar. When not cast solid with the locomotive or tender frames, the bolts or rivets securing them should be of such size and so applied that their holding power will be as strong as the drawbar. The clearance in pocket above the drawbar or safety bar must be sufficient to prevent binding of the bar when there is vertical movement between engine and tender due to inequality in the track, frog, crossings, etc., and in passing over the ends of turntable. At the same time, this clearance should not be so great as to place supports of the pin so far apart as to cause the pin to bend. This clearance should be at least ¾ in., should not usually exceed 1½ in., and 1 in. is usually good practice.

There should be ample clearance in the pockets around the sides and ends of bars to prevent the bars binding when the locomotive is passing over curves. It is good practice to provide a minimum clearance of two inches on each side and at the end.

Federal Law on Safety Bars

The second paragraph of Item No. 22 of Federal rules and instructions for the inspection and testing of locomotives and tenders is as follows:

"Two or more safety bars or safety chains of ample strength shall be provided between locomotive and tender, maintained in safe and suitable condition for service, and inspected at the same time draw gear is inspected."

Inasmuch as the government standard locomotives were equipped with central safety bars, and a great many other locomotives have been built with the same arrangement, there is evidently no tendency to enforce the letter of this law. To prevent any opportunity of confusion, it is recommended that the association request an amendment to this rule, to read as follows:

"One safety bar of the same strength as the drawbar, located immediately above or below the drawbar, or two or more safety bars or safety chains of ample strength, located one on each side of the drawbar, shall be provided between locomotive and tender, maintained in safe and suitable condition for service, and inspected at the same time draw gear is inspected."

The report was signed by M. H. Haig (Chairman), Atchison, Topeka & Santa Fe; I. A. Seiders, Philadelphia & Reading; W. S. Jackson, Erie, and H. A. Hoke, Pennsylvania System.

Discussion

At the conclusion of the presentation of the report, Mr. Haig explained that the use of the central safety bar is contrary to the letter of the Federal law, but considering the practical usefulness of the central safety bar, it is recommended that the Association shall request an amendment to the present ruling.

This proposed amendment appears on Page 20, and is as follows: "One safety bar of same strength as drawbar, located immediately above or below drawbar, or two or more safety bars or safety chains of ample strength, located one on each side of drawbar, shall be provided between locomotive and tender, maintained in safe and suitable condition for service, and inspected at the same time the draw gear is inspected."

W. H. Winterrowd (C. P.): The Canadian Pacific has used the drawbar of a built-up type, which has proved very successful in service, which covers a period of 10 years to my personal knowledge. That drawbar is built up of six ½-in. plates riveted together with two rivets at each end, sufficient metal being provided outside of the edge of the hole to permit the stress to remain reasonable.

That drawbar has indicated several advantages, the chief one being that if there should be any tendency to failure, one of the laminations can break and the entire bar not fail.

W. F. Kiesel (Pennsylvania): This report seems to require nothing but wrought iron drawbars. There are many drawbars in existence today made of axle steel. Axle steel is better and stronger than wrought iron for the purpose. It therefore seems that axle steel or any other steel of a similar carbon should be admitted.

In the car construction committee the recommendation was made that the drawbars and drawbar attachments for cars be increased from a value of 10 sq. in. to 12 sq. in. It seems reasonable that the drawbar between engine and tender should never be less than that, because if you double-headed train, the second engine becomes automatically a part of the train; therefore the drawbar connection between the engine and tender should be as strong as we require between cars. It is imperative that we should say the drawbar shall never be less than 12 sq. in. of cross-section, and on the basis of the stresses they allow, this would mean that any engine with a drawbar pull of 54,000 lb. or less must have 12 sq. in.

I fully agree with the committee that if at all possible a drawbar should be straight and not bent. A bent drawbar is always a nuisance, and I believe engines can be built with the drawbar straight.

Frank McMamany (U.S.R.A.): I am inclined to disagree with the conclusions of the committee on page 2 with respect to the minimum factor of safety of drawbars between locomotive and tender. I believe a factor of 10 is entirely too low to provide proper safety. The previous speaker, referred to the simple method of placing one locomotive ahead *of the other,* and as double-heading has not gone out of practice, by any means, we have reduced the factor of safety on that drawbar to 5 if the additional locomotive is of equal tractive power; and, if greater, we have reduced it substantially lower than that. But drawbars do not fail as a general proposition under ordinary service conditions when the locomotive is pulling steadily. They fail as the result of shock and I think that we all have records of cases where, with a single locomotive, due to the application of the air from the rear of the train or some similar cause, the actual strain on the drawbar was more than five times the tractive power, and if we put another locomotive ahead of that, our factor of safety becomes a minus quantity.

In the record I wish to say that I do not intend in my remarks to use trade names. I am speaking of the individual safety bars. So that while the rule has never been changed, permission has been granted to use the individual safety bar as constituting an equally safe and perhaps a safer arrangement than the double bar. In my own opinion it is a safer proposition, and the factor of safety which would be satisfactory for the single bar might be entirely unsatisfactory for the double bar. But for either I think the factor of safety is too low.

Mr. Kiesel: In regard to what Mr. McManamy just said, I would like to ask him one question: If the drawbar at the rear of the tender has a value of only 12 sq. in., why should an engine that has a drawbar pull of 150,000 lb. have more than 30 sq. in.? It does not seem logical, because if a break occurs it certainly will break the 12 sq. in. rather than the 20 or 30, and I do not see why a factor of safety of more than 10 should be used in a case of that kind.

Mr. McManamy: There are two reasons. The first is the fact that drawbars do fail between the engine and tender, rather than at the back of the tender, and the second is the disastrous results of failure between the engine and tender rather than at the back of the tender. We want to make the failure at the rear of the tender, if we are going to have a failure, rather than between the engine and tender, and that is the reason we have a strong safety bar, and that is the reason the bar is provided between the engine and tender. The results of failure between engine and tender have proven so disastrous that it has been necessary for us to constantly keep on the lookout for improvements and additional strength in these safety bars, to prevent the serious accidents which result from failure at that point.

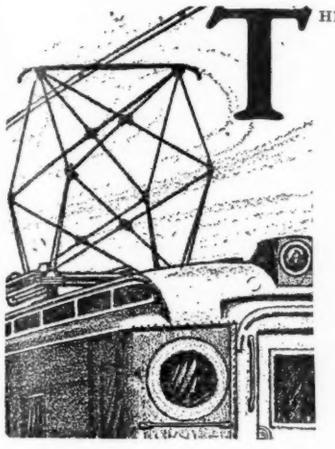
J. A. Pilcher, N. W.: In the discussion of the idea advanced by Mr. Kiesel, Mr. McManamy spoke of the break between the engine and tender, and in referring to that point I am sure he did not have in his mind any engine such as Mr. Kiesel had reference to. I do not think he will find any record of breakage of drawbars of such a size in connection with any such engine. While a factor of 10 might be raised slightly, a factor of 20 would require 60 sq. in. in the drawbar with 150,000 lb. tractive locomotive a pretty ponderous sort of a device to handle.

Mr. McManamy: I would like to ask the members, in considering what I said, to think of what I actually did say, and not of what I probably thought. As a matter of fact, records are in existencse to-day of failures with very serious results on the same type of locomotive, and I think we are entirely justified, as long as the practice of double-heading exists, in asking for a factor of safety greater than 10.

There is a further question—if the average locomotive is constructed with a factor of safety of 20 or 22 why should this Association go on record as indorsing a minimum factor of 10? I have found a very strong and almost uncontrollable disposition on the part of mechanical officers of railroads to work to minimums.

A. Kearney (N. & W.): *I move that the report be received and printed in the record. This motion duly seconded and carried.*

Design, Maintenance and Operation of Electric Rolling Stock



THE REPORT OF THE COMMITTEE this year consists of individual papers, written by the various members, showing the development of several of the important electrification projects on American steam railroads, as follows:

Exhibit A.—Baltimore Tunnels, Electrification, Baltimore & Ohio.

Exhibit B.—New York Central Electrification, New York to Harmon.

Exhibit C.—Brief History of New York, New Haven & Hartford Electric Rolling Stock.

Exhibit D.—Great Northern Electrification, Cascade Tunnel.

Exhibit E.—The Hoosac Tunnel Electrification, Boston & Maine.

Exhibit F.—Electric Operation on the Butte, Anaconda & Pacific.

Exhibit G.—Historical Sketch, Norfolk & Western Electrified Lines.

Exhibit H.—Chicago, Milwaukee & St. Paul, Synopsis of Electrification.

Exhibit I.—The Long Island Electrification.

Exhibit J.—Electrification of the Southern Pacific's Oakland, Alameda and Berkeley Suburban Lines.

Abstracts of the papers, some of which are quite voluminous, are presented below.

The report is signed by C. H. Quereau, N. Y. C.; G. C. Bishop, L. I.; J. H. Davis, B. & O.; G. McCormick, S. P.; H. R. Warnock, C. M. & St. Pa.; W. L. Bean, N. Y. N. H. & H.; J. T. Wallis, Pennsylvania; J. A. Pilcher, N. & W.

Baltimore Tunnels Electrification, Baltimore & Ohio

Three general types of locomotives have been used. The first two, being pioneers for steam railroad service, are of interest primarily only from a historical point of view. The class LE-2 are still in operation, although they are of a design that would now be considered obsolete. An interesting feature with respect to these locomotives is that they are today handling the maximum tonnage freight trains operated over the division, notwithstanding the fact that during the period they have been in service steam motive power has been replaced twice in order to secure greater capacity. This has been possible due to the flexibility of multiple unit control in that when they were first built they were operated in two-unit combinations, while they are now run as a three-unit combination, thus providing a 50 per cent increase in capacity.

The locomotives purchased in 1910 and 1912 are of the Detroit tunnel type and might be considered as standard for the present electrification. This design has been found to be very satisfactory for limited zone, moderate speed service in that they are practically equally well adapted for passenger, freight and switching service. Future additions will probably be of this type with minor modifications to increase their capacity slightly.

The report included also data concerning the current collecting system and the performance of various types of rail bonds.

New York Central Railroad Electrification, New York to Harmon

This operation was begun with 35 locomotives and 180 multiple unit cars, of which 55 were trailers which were subsequently equipped with motors. At present there are 73 locomotives and 241 motor cars. A direct current, rather than alternating current, system was adopted because of insufficient practical experience with the alternating current for a trunk line problem requiring the highest possible reliability of service, restricted overhead clearance in the Park Avenue tunnel, which prevented the use of overhead conductors, and legal obstacles to the use of high voltage overhead trolley lines within New York City.

The operating service obtained from this equipment has been more reliable, with fewer delays, than was obtained from the steam locomotives which were displaced, and very satisfactory indeed, conditions in the tunnel included. The following table shows the record of train detentions due to failure of the equipment for the year 1918 for electric operation, and the year 1908 for steam. All detentions are included:

ELECTRIC OPERATION, 1918

All locomotives

No. detentions	Miles run	Miles per detention
37	1,854,700	50,127

M. U. CARS

71	5,926,301	83,469

STEAM OPERATION, 1908

Hudson Passenger Division

664	4,014,980	6,045

The inspection, repairs and maintenance of the electric equipment of cars and locomotives has proven to be a comparatively simple and inexpensive process, costing less than that of steam equipment:

INSPECTION AND REPAIRS OF ELECTRIC LOCOMOTIVES

Year	Cost per 1,000 miles Labor	Material	Total
1912	$18.88	$14.60	$33.22
1913	19.82	14.54	34.36
1914	21.55	21.34	42.89
1915	19.01	13.79	32.80
INSPECTION AND REPAIRS OF MULTIPLE UNIT CARS			
1912	$11.34	$7.40	$18.74
1913	10.09	7.47	17.56
1914	10.13	9.19	19.32
1915	12.56	12.25	24.81

These figures, as well as those for the locomotives, are fair averages of cost for the twelve years of electric operation until the year 1918, when wages were appreciably increased by the government.

In this connection it should not be forgotten that the figures given do not include fixed charges, which must be included in arriving at the comparative cost of steam and electric operation.

Experience has shown that it requires less electric locomotives than steam for the same amount of work. This fact is due to several electric characteristics, among them two which are very evident. One of these is the fact that no time is lost by the electric equipment in having fires cleaned and supplies of coal and water furnished. Again, the electric locomotives take the slack and handle their loads with more snap than the steam engines. The following table gives the number of steam and electric locomotives required in several districts:

ENGINES USED—HUDSON DIVISION

Steam	Electric
53 engines and 78 coaches.....	17 engines and 97 multiple unit cars.

HARLEM DIVISION

41 engines and 95 coaches.....	11 engines and 116 multiple unit cars.

New York, New Haven & Hartford Electric Rolling Stock

The present electric rolling equipment of the New Haven on its principal electric division, namely, New York to New Haven,

consists of 104 electric locomotives, 27 multiple unit cars and 52 trailer cars. All operate at 11,000 volts, single-phase, alternating current. Some are arranged to operate at 660 volts direct current, also, in order to enter New York City over the tracks of the New York Central or Pennsylvania.

Although designed at a time when information on the requirements of an alternating current, high voltage, high speed, heavy train capacity locomotive was very meager, the locomotives are today comparable with those designed in the light of all the experience gathered in the last thirteen years. This is the more noteworthy when it is remembered that most electrical apparatus becomes obsolete often before sufficient time has elapsed to get it erected and going. In general design the last locomotives purchased in 1910 are the same as those purchased in 1919, most of the principal improvements of the 1919 lot being in the auxiliary apparatus and the control apparatus. The general features are the same as those of the locomotives designed today, which extended service and experiment have proved best. Some of the experimenting of the New Haven was carried out by building one locomotive of each type. The locomotives of the New Haven may be divided below into two groups, (I) the standard types, (II) the experimental types.

I. Standard

		Wheel arrangement
1—Gearless motors for fast passenger service. First type built. Now obsolete for single phase	01-041	2-4-4-2
	Frt. 076-0111	2-4-4-2
2—Geared passenger, freight and switcher locomotives	Sw. 0200-0214	0-4-4-0
	Pass. 0300-0304	2-6-2-2-6-2

II. Experimental

		Wheel arrangement
Geared 3-truck fast freight or passenger locomotive.	069	2-4-4-2
Geared 2-truck fast freight or passenger locomotive.	071-2	2-4-4-2
Geared side rod freight locomotive	068	4-4-4-4
Side rod locomotive	070	2-4-4-2

The above list contains locomotives which represent every mechanical type of drive put forth to date, either in this country or in Europe, as the best solution for transmitting the torque of the motors to tractive effort at the rim of the driving wheels. The type that proved best for passenger and freight service is represented by New Haven locomotives 076-0111 and 0300-0304. This is a geared type with twin motors, that is, two motors bolted together and driving one pair of wheels through helical springs.

Through the gearless locomotive of the 2-4-4-2 type (01-041) has given very good service for the past twelve years in both local and fast express service, it is now replaced by the geared locomotive of the 0300-0304 type. The other types listed under "experimental" have not proved successful and will not be duplicated on the N. Y. N. H. & H. The type represented by locomotive 068, with a geared side rod drive and a 4-4-4-0 wheel arrangement, has been used for polyphase motor drive to obtain certain advantages possible with such a combination. These advantages are not available with single-phase commutator motors. As for the side rod type, represented by locomotive 070, wheel arrangement 2-4-4-2, no new standard gage locomotives of this type have been designed in recent years in this country. For narrow gage roads, where a large motor would not fit between wheels, the type has its advantages; but for main line, standard gage, high speed, heavy tonnage service it has not proved successful on the N. Y. N. H. & H.

Great Northern Electrification, Cascade Tunnel

In the year 1908 construction was begun of power plant, transmission line, sub-station, trolley system for Cascade Tunnel and four electric locomotives were purchased. Work was completed late in the year 1909 and operation begun, and this operation has been successful ever since. The power plant is located at a point thirty miles east of Cascade Tunnel on the Wenatchee River, and consists of three water-wheel driven generators, each of a horsepower capacity of 4000. The locomotives weigh 115 tons each. All driving wheels are traction wheels, each motor being coupled to its axle in identically the same manner as is done with street-car motors, being geared in single threads. An interesting feature is that there are no cushion springs in the gear in order to equalize the tooth pressure, as has been considered necessary on almost all heavy locomotives; and we find that there is an equal amount of wear on both pinions, the tooth pressures seem to be uniform, and the wear up to date has been almost negligible on all of these gears and pinions. The current is conducted into the locomotive by two regular street-car trolley poles and wheels located at each end of each locomotive. The speed of the driving motors is constant, being of the induction type, and drives the locomotive at a constant speed of 15 miles per hour. The reason for this constant speed was that this was supposed to be a link in a larger system in which the principle of regenration on descending grades is very desirable, and it was at the time the only method of regenration which had been developed. The results of this regeneration were such that this feature was shown to be very desirable for all electrification, especially of mountain grades, and since that time the General Electric Co. has developed the regenerating locomotive, using the series direct-current motor, something which up until a few years ago was considered almost impossible of accomplishment.

The following is data on cost of operation:

Repairs per locomotive mile	$7.53
Wages	27.39
Lubrication	.20
Supplies	.33
Total	35.45

Miles made per pint of cylinder oil, 313. Miles per pint of car oil, 19. Average gross tons per engine mile, 345. It is to be noted that every train has three electric locomotives, consequently the tonnage per train is three times this, or 1035 tons. Toal passenger car miles, 48,096. Toal number of tons one mile is 8,461,770. This data applies to the year 1918.

The Hoosac Tunnel Electrification—Boston & Maine

The Hoosac Tunnel electrification, extending for a distance of 7.9 miles east of North Adams, Massachusetts, and embracing 4¾ miles of double track tunnel, was undertaken primarily to increase the capacity of the tunnel and to make train operation more safe through the elimination of the use of steam locomotives.

The original electrical equipment comprised five alternating-current locomotives of the 2-4-4-2 type developing 51,000 lb. tractive effort as a maximum—20,500 lb. continuously—and working under a trolley pressure of 11,000 volts. Two locomotives of similar characteristics were added in 1917. These locomotives handle 1750 tons behind the steam locomotive, this being the maximum tonnage assigned for steam operation with one locomotive over this section of the division.

The results, in added capacity, safety of operation, and in decreased track maintenance, have been those indicated when the project was undertaken.

Electric Operation on the Butte, Anaconda & Pacific

The Butte, Anaconda & Pacific Railway was built in the year 1892, principally for transfer service between the ore mines in Butte and the Washoe Smelter at Anaconda. The tracks connecting these two cities are approximately twenty-six miles long, but the yards and sidings included in the present electrification bring the total mileage up to 120.

Until the Butte, Anaconda & Pacific Railway Company decided upon the electrification of its line, for economical reasons alone, it is questionable if any such steps had been made by steam line railroads. The electrification of various steam roads has been for the purpose of obviating some special condition, such as smoke nuisances in tunnels or cities, congested terminals, or to accomplish some special work which a steam engine could not be used to do.

Tabulated results from a comparison of the delays to passenger trains for the month of June, 1913, under steam operation, with the same month in 1914 under electrical operation, are shown. While the month of June is selected at random, the results are considered representative of the general performance.

The average cost of maintenance of overhead system per mile per year for the past four years is $137.57. The year 1918 will give an idea of the proportionate cost for each item considered.

Recent measurements of our trolley wires indicate that the major portion of our overhead wires will last fifteen years.

While there are a number of places that will wear out in less time, there are other places which will wear much longer than fifteen years, depending on the frequency of movement and current collected. The greatest wear, as would be expected, comes at rigid points, such as pull-offs and rigid hangers.

TABLE 1

Number of trains	Meeting points Hr.-Min.	Delays on account engine and power failures Hr.-Min.	Lost running time Hr.-Min.	Total delays all cases Hr.-Min.
Steam, 1913.....272	15-49	0-44	4-13	20-46
Electric, 1914.....280	3-54	0-51	0-25	5-10
Decrease 8*	11-55	7*	3-48	15-36
Percentage saving due to electrical operation:				2.94%*
				75.66%
				15.91%*
				90.10%
				75.12%

* Increase.

Coaches are heated in the following manner. Each coach heater is of 25 kw. capacity, having a thermostat control, and operating on 2400 volts. The contactor control for each equipment receives a potential of 600 volts from a dynamotor located on the locomotive. Fresh air is introduced into the heater by means of a fan, and after being heated to a temperature of 100° to 105° C. is forced out through longitudinal ducts placed inside the coach. The heater, principally because of high voltage, is located below the floor. Heater and piping are lagged with heat insulating material. Three electrical workers are employed

Poles and fixtures		Feeder		Trolley		Bonding	
Labor	Material	Labor	Material	Labor	Material	Labor	Material
$3,261.52	$687.46	$554.10	$87.77	$3,889.79	$1,168.86	$1,410.96	$1,980.23

Total of above accounts	$13,040.69
Motor Car M 1	1,119.65
Work train	2,290.04
Total maintenance expense	$16,451.08
Number of miles operated	120.27
Cost per mile per year	$136.78

at the machine shop to make such repairs as are necessary on electric locomotives, shop light and power, coach heating and lighting, as well as assisting in the maintenance of block signals and dispatcher's telephone.

	Cost Per Year for Repairs					
	1914	1915	1916	1917	1918	1919
Number electric locomotives	17	18	21	24	28	28
Average locomotive weight, tons	80	.....	.....	.....	.....	.....
Installation date	1913					
Route miles electrified	30	.....	.....	.....	.....	.....
Miles single track basis	90	90	114	114	120	122
Maintenance of Electric Locomotives						
Repairs in dollars	27,811	35,253	49,811	55,846	54,167	35,264
Depreciation in dollars	26,829	.....	24,143	36,695	32,707	33,567
Electric Locomotive Mileage						
Freight revenue miles	321,946	317,595	505,162	412,509	413,519	226,851
Passenger revenue miles	65,428	87,625	100,290	94,659	80,020	90,805
Switch revenue miles	136,892	161,871	404,356	367,690	324,322	197,838
Mixed and special revenue miles	.....	.....	616	456	.....	.....
Total revenue miles	524,266	567,091	1,011,424	875,314	817,861	515,474
Non-revenue miles	.....	5,507	2,477	10,796	2,957	1,142
Total locomotive miles	524,266	572,598	1,013,901	886,110	820,808	516,616
Maintenance per locomotive mile in cents. (Not including depreciation)	5.3	6.16	4.91	6.3	6.4	6.8

The average time for each locomotive in the shop per year is ten days, while the shortest is four days. During this time a general overhauling is given to the mechanical and electrical equipment. The time for electrical inspection and repairs varies with the class of service which the locomotive has been worked at most. In general, the electrical work is completed in less than two days, bad rheostat connections and tight contactor pins giving the only cause for electrical work in the cab.

It is stated in conclusion that the performance of these locomotives through heavy snow is superior to that of steam locomotives under similar conditions.

Norfolk & Western Electrified Lines

The Norfolk & Western Electrification is on a portion of the Pocahontas Division, familiarly known as the Elkhorn grade.

Along this division are numerous colliery sidings and short branches penetrating the developed coal fields, so that the normal service consists in collecting loaded cars or trains from the sidings and branches for eastbound trips and delivering empties on the return. Thus many conditions are favorable for electric traction, namely: An entire short operating division on which electric power may be substitued for steam between engine terminals without shortening or interfering with adjoining operating divisions, heavy grades where power requirements are great, and a large volume of traffic which taxes the capacity of the line because of physical limitations and slow operating speeds. In this case the primary objects of electrification were the increased capacity of the line, and economy and increased efficiency of the service generally.

With the first study the source of power was to be gas engines using waste gas from by-product coke ovens, which were to succeed the bee hive coke ovens, which were very numerous in the vicinity. The use of gas engines was abandoned when it was found that the coal in this immediate vicinity, which is the Pocahontas coal section, did not have sufficient volatile matter to make the by-products ovens profitable.

The construction was actually started in 1913 and the locomotive operation, was actually started by Gibbs & Hill in April, 1915, and by the Norfolk & Western Railway in July, 1915.

The conditions of steam operation had very materially changed since the first observations were made. The Norfolk & Western Railway Company had purchased quite a number of Mallet locomotives, each of which could take about 1080 tons up the ruling grade on this division, instead of from 580 to 600 tons.

The allowable weight per axle had increased from 42,000 lb. to 55,000 lb. At the present day the allowable load per axle on electric locomotives is 68,000 to 70,000 lb.

The eastbound load had gone up to about 50,000 gross tons per day. The capacity of the electric equipment, as installed, could handle an average of about 65,000 tons per day, in addition to handling the through freight trains by electric pushers and the passenger trains with their steam locomotives by attaching electric engines. In the latter case the necessity for an electric helper occurs only where the train is so heavy as to require doubleheading on the grade.

In connection with the steam operating conditions—it was customary under steam operation to make up the train to a maximum weight of 3250 tons behind the engine and to handle it by a Mallet road engine and a Mallet helper over the division, and, in addition, a Mallet pusher up the 1.5 per cent and 2 per cent grades, or three engines per train. In cold weather and under adverse conditions the trains were reduced to about 2900 tons. The engines were of the latest compound type fitted with mechanical stokers and superheaters. They weighed about 370,000 lb. on drivers and 540,000 lb. total, including tender, and had a tractive power of about 85,000 lb. Tonnage trains were handled normally at speeds of seven miles per hour or eight miles per hour on the grades, but on account of the ventilating conditions the speed was reduced to six miles per hour in the Elkhorn tunnel. This tunnel is equipped with the Churchill method of forced ventilation, which consists of blowing air through annular nozzles in the direction of the up-grade movement and at a slightly greater velocity than the speed of the train, thus blowing the smoke from the head of the train without having the smoke from the rear engine reach the front engine during the tunnel movement.

Because of the slow speed in this tunnel, and also because of the fact that it is of single track, a serious restriction in the capacity of the line occurs at this point and has occasioned frequent congestion and delay. Generally, however, the division is double track throughout, with frequent long passing sidings, making it in part a three-track line. Sixty per cent of the entire division is on curves, the maximum curvature being 12 deg. on the main line and 16 deg. on sidings.

The decision to electrify was arrived at about seven years ago and followed a careful study by the officials of the road of the actual steam operating costs on this particular division. This was done by keeping a complete detailed record of the operating costs, as well as a tabulation of the failures and delays of each steam locomotive. In this way it was not necessary to take average costs, which included operation on other divisions and under other conditions, in making comparisons with estimates of electric operating costs.

The question of a proper electric system was given especially careful study because of the difficult physical conditions and the unprecedentedly heavy haulage requirements. It was apparent that an electrified third rail along the tracks was not practicable under the local conditions and that some system using an overhead collector would be required. This narrowed down the problem to a decision between the high-tension direct current and the high-tension alternating current systems. Analysis of both first costs and operating cost, as well as consideration of the local operating conditions, indicated that the single-phase alternating current system was the one that should be adopted.

Attention might be called here to the fact that these heavy trains require enormous power for their movement, which in turn means large currents to be collected if the potential is low, but is effected with much smaller currents if a system with the maximum allowable potential is used. The practical difficulties of collecting large currents from an overhead wire are well known, and the adoption, therefore, of a high trolley voltage was a logical solution of this problem. Electric braking down heavy grades, accomplished in a simple manner, was another attractive operating feature of the system adopted.

In working out the details of the installation a number of novel features were introduced, notably in the adoption of three-phase motors on the locomotives in connection with single-phase current delivered to the locomotives. The required three-phase current for the motors is produced by a "phase-converter," which is a simple self-contained piece of apparatus. The three-phase motor used for driving the locomotive is an unusually rugged piece of electrical machinery requiring no commutator and having high weight efficiency, or capacity for given weight and dimensions. It has, however, a constant speed characteristic which is not desirable in some kinds of railroad operation, but for this particular service has important advantages in respect to maintaining certain predetermined and limited train speeds irrespective of the loads. Furthermore, this type of motor has the valuable characteristic of automatically returning regenerated current to the line on the down grades, this being effected without additional machinery or complication when the predetermined running speed is slightly exceeded during the coasting period. This characteristic may, at times, result in a considerable saving of power as the regenerated current is available for use in assisting to propel other trains which are in movement on the division, but its most valuable feature is that of "dynamic braking," or the holding of the train at a uniform speed on down grades without the use of air brakes.

Twelve electric locomotives have been provided for the service, replacing 34 Mallet steam locomotives. Each electric locomotive consists of two units weighing 135 tons, giving a total weight of 270 tons for the complete locomotive. The frame of each unit consists of two trucks connected by a Mallet type hinge, and each truck has two driving axles included in the rigid wheel base with a radial two-wheel leading truck. The bumping and pulling stresses are transmitted through the main trucks frame and through twin draft rigging mounted on the main trucks at each end of the unit. The main trucks each carry two motors framed into the truck and both meshing into the same gear on each end of a jackshaft. The main gears are provided with crank pins from which connection to the driving-wheel cranks is made by side rods in the usual manner. By this arrangement the motors are carried on the main locomotive springs and are thus thoroughly cushioned against shock. Each half of the locomotive is provided with a cab supported on the trucks entirely by spring cushioned friction plates. The center pins carry no weight and serve only to maintain the cab in its proper position on the trucks. The cabs contain all current controlling and transforming apparatus, air-brake pumps, reservoirs, and the usual appurtenances for the locomotive operation. There are two running speeds for the locomotive, namely, 14 miles per hour and 28 miles per hour.

The drawbar pull of the locomotive varies from a maximum of 114,000 lb. during acceleration to the 14-mile speed to 86,000 lb. when operating at this speed uniformly on a 1 per cent grade, but on test the locomotive has developed a tractive effort in excess of 170,000 lb. This indicated, however, a coefficient of adhesion which cannot be assumed in practice. The maximum guaranteed accelerating tractive effort per locomotive is 125,000 lb.

A valuable characteristic of this type of electric locomotive is its capability of safely exerting full tractive effort for a considerable time while standing. The utility of this will be seen when it is remembered that the trains hauled are generally over one-half mile in length, or three-quarters of a mile in the case of an empty train. When starting there is sometimes difficulty in getting coincident action between the head and rear locomotives, and thus it is specially important that both locomotives may be able to exert their full tractive effort for an appreciable time to take care of delays in getting into full action. Consequently, the motors have been designed to permit full load current to be applied for five minutes without movement.

Electric operation has been in service too short a time to give data as to performance, but it may be said that the estimates of increased capacity to be obtained from this equipment have been fully met and that an unusually heavy tonnage has already been handled without congestion, and the gathering and delivery tracks kept clear. The movement of the heavy tonnage trains by electricity has been effected with ease and smoothness; the trains accelerate promptly and without shock or jerk on the heavy grades, and it has been found that the full trains can be smoothly controlled by one head engine on the 2.5 per cent down grade by electric braking alone and at a uniform speed slightly above that of the regular running speed. The acceleration of one of these heavy trains is impressive as regards the amount of power required. Preliminary tests indicate that getting a train in motion up the grade requires as much as 11,000 electrical horse-power and that running at uniform speed up the grade requires 8,000 electrical h-p. to be delivered to the train. It is believed that no such amount of power has ever before been developed on a single train, either steam or electric, in regular service.

Electrification on the Chicago, Milwaukee & St. Paul

The Chicago, Milwaukee & St. Paul were first interested in electrification at the time their extension from the Missouri River to the Pacific Coast was under construction.

The section under consideration was through the Bitter Root Mountains, and the reason for its consideration was to lessen the fire hazard, as the line was building through a very extensive and important forest reserve of the United States Government.

The power was to be developed from a number of sites on the St. Joe River. The plans for this electrification were developed by consulting engineers who had decided upon a single phase trolley. The plan was abandoned owing to the insufficiency of the power available on the St. Joe River. In the meantime the road secured a site for power development on Clark's Fork of the Columbia River at Thompson's Falls, in Idaho.

The time which had elapsed did not permit of this development to provide for the initial operation of the road so that the Pacific Coast extension was placed in operation with steam locomotives using oil for fuel through the forest reserve.

The Chicago, Milwaukee & St. Paul in their operations to secure terminal facilities at Butte and to secure traffic for their new road, established relations with the Amalgamated Copper interest in Montana and acquired a substantial interest in the Butte, Anaconda & Pacific Railroad, which was owned by the Amalgamated Company. About this time the Great Falls Power Company, which was also controlled by the copper interests, was seeking a market for power from their important development, and to that end acquired the Madison River Power Company and the Butte Electric Company, which were controlled by Mr. C. A. Coffin, President of the General Electric Company, and affiliated interests, the combination being called the Montana Power Company.

About this time a representative of the General Electric Company made a report on the electrification of the Rocky Mountain Division of the Chicago, Milwaukee & St. Paul, based upon duplication of the locomotives and substation apparatus in use on the Butte, Anaconda & Pacific. The traffic was assumed to be five 1600-ton freight trains each day in each direction, two through passenger trains and one local passenger train each direction over a section of the line daily, the service to accommodate this traffic was laid out upon a train sheet and the use of power represented to be maximum of 10,000 kw. with an average of 6500, no consideration of regeneration or control of peak having been contemplated.

Based upon this report the contract was made with the Mon-

tana Power Company for a nominated sum of 10,000 kw. for the Rocky Mountain Division with options provided under certain terms for an increase to a maximum of 25,000 kw. The contract further provided that apparatus would be secured by the railroad capable of regulation of power factor, and that a minimum monthly charge would be equivalent to an average of 60 per cent of the nominated maximum power.

The railroad entered into a similar contract for the extension of the electrification to include the Missoula Division from Deer Lodge, Mont. to Avery, Ida., this involving as well the transfer of the Thompson's Falls Power site to the Montana Power Company's interests. About this time it was found that the original basis for the company's load diagram was fictitious, that the traffic was not balanced east and westbound, but fluctuated widely, due to seasonal and local variations. It was also concluded that 1600 ton trains in trans-continental service were entirely too small for the efficient movement of traffic. This led to the determination that the minimum trains should be 2500 tons hauled by a single locomotive on a one per cent grade. A third conclusion was that the topography of the road was particularly suited to regeneration and that this would be required. A fourth conclusion, which was insisted upon, was that automatic means should be provided for the limitation of the maximum demand for power.

The Westinghouse Company submiteed an analysis including an estimate on the cost of electrification, based on a single phase trolley, split phase locomotives for freight service, series commutator motors for passenger service and sub-station apparatus, to convert from 60 cycles to automatically reduce both voltage and frequency when the demand exceeded the predetermined peak setting. Each locomotive and each dispatcher's office to be equipped with frequency meters so that at all times those interested in the condition of power demand would be able to function advisedly.

At this time the question arose as to the engagement of an independent consulting engineer, but at a subsequent meeting of the Board of Directors of the Railroad Company, it was voted that the road would not employ an independent engineer and formal action was taken that the electrification would be affected by high voltage, direct current, the same as the Butte, Anaconda & Pacific, the position having been reached without engineering analysis and no further consideration has been given to the question of choice of system.

The entire undertaking was committed to a vice-president in charge of electrification, who employed as his assistant an electrical engineer to work out the technical detail. The analysis of the probable load conditions with 2500-ton trains led to the conclusion that a voltage higher than 2400 was economical and desirable and should be available.

Supporting this position was a demonstration by the Westinghouse Company of a high voltage car equipment which was operated at 6000 volts, direct current, and this led to the insistance that 3000 volts would be the nominal operating voltage to which the General Electric Company finally agreed.

The contracts finally made with the General Electric Company covered the present electrified section of 440 miles from Harlowton, Mont. to Avery, Ida. The technical requirements as to detail of sub-stations, transmission line, trolley construction, and locomotives were most precise and the response of the General Electric Company to the exacting specifications was complete, so that the execution of this electrification has been unique in the perfection of its detail.

The maintenance of the electrical equipment has been handled with equal skill. However, it is granted that the conditions local to this section of the country contribute toward this result, so that overloading, abuse or neglect in the operation of this equipment may be considered to have been entirely absent throughout its whole history.

The technical result of the electrification has been quite a success. The financial result, due particularly to fuel and labor conditions, and the indirect value due to the publicity of this operation, are equally as satisfactory.

In addition to the electrification of the Rocky Mountain and Missoula Divisions, the railroad began, in March, 1917, the electrification of an additional 207 miles of main line on the Columbia and Coast Divisions extending from Othello to Tacoma, Washington, and to Black River, nine and one-half miles south of Seattle, across the Saddle Mountains just west of the Columbia River and the Cascade Mountains.

The general character of the electrical layout is similar to that used in Montana and Idaho, except as may be noted below:

Locomotive for passenger service will be of the G. E. bi-polar type, having a total weight of aproximately 265 tons and capacity sufficient to haul over the profile at a speed of approximately 25 miles per hour a twelve-car passenger train weighing 960 tons. Delivery of these locomotives will commence in August. Locomotives for freight service will be provided by changing the gear ratio of the present passenger locomotives used on the Rocky Mountain and Missoula Divisions, and in place of the latter locomotives there will be provided for the Rocky Mountain and Missoula Divisions ten quill-type locomotives manufactured by the Westinghouse Electric & Manufacturing Company, having approximately the same weight and capacity as the bi-polar motors just referred to.

Power will be supplied over two transmission lines, one running from the Long Lake plant of the Washington Water Power Company to the Taunton sub-station, and the other from the Snoqualmie plant of the Puget Sound Traction, Light & Power Company to Cedar Falls and Renton sub-stations, these lines connecting at the sub-stations mentioned with the railroad's high tension tie line. It is planned to have this section under electrical operation by October of this year.

The Long Island Railroad Electrification

In 1905 the Long Island Railroad Company began electric operation on a portion of their lines.

It was the first complete electric service on an extensive scale of a steam railroad and is still the most extensive example of multiple unit passenger train operation.

The Long Island is essentially a passenger line, serving the residential suburbs of New York city and a heavy excursion business to the seashore of Long Island.

A network of lines of the company covers the western end of the island within 30 miles of New York City and delivers heavy commuter and excursion travel to the New York and Brooklyn terminals.

The electrification covers practically this network, and within a radius of 30 miles contains 88 route miles with a total main line track mileage of 187 miles, giving a frequent and quick service without transfer from the heart of Manhattan and Brooklyn boroughs of New York City to the terminus of the commuter zone, and to several points on the seashore.

Steam operated express trains to the eastern end of the island are taken from the Pennsylvania Station by electric locomotives to Harold Avenue, Long Island City, at which point steam locomotives are attached. It is probable that in the near future electric locomotives will haul these through trains to Jamaica, which is a central point for the various lines. The freight service is still conducted by steam, and on some portions of the electrified system steam locomotives are used to operate both freight and through passenger trains.

The third-rail, a. c. d. c. system is used with 650 volts D. C. on the third rail and three-phase, 25-cycle at 11,000 volts on the transmission lines.

The power is obtained from the Pennsylvania Railroad power house located at Long Island City and is delivered to the Long Island transmission lines at 11,000 volts.

The 134 passenger cars ordered for the lines electrified in 1905 were of steel and differed only from the New York subway trains in platform construction and other minor parts. They are 41 ft. over body corner posts, with a total length over drawbars of 51 ft. 4 in., and are 8 ft. 8 in. wide over eaves, and weigh equipped 79,664 lb.

Five wooden express cars were also provided at this time, equipped with the standard type of motor and trailer truck and with the same electrical equipment as the above passenger cars. These cars, 52 ft. 5 in. over all in length and 9 ft. 9½ in. in width, weigh about 76,500 lb. They are equipped with standard A. R. A. couplers to enable them to haul the old standard steam baggage and express cars as trailers.

In anticipation of the opening of the Pennsylvania Station and the operation of electric trains between Jamaica and points beyond, orders were placed during 1909 and 1910 for 150 steel passenger, passenger and baggage cars and seven steel baggage cars. For the same reason, 50 steel passenger cars of the same type were built in 1908 but were not electrically equipped at that time, and were used in the steam service until needed later in electric service.

In 1912 20 more passenger and five combination cars were built, and in 1913 and 1914 50 more passenger and 12 more combination cars were added. The new passenger cars differ from the first cars, in many important details of design and equipment. They are 54 ft. 6¼ in. long over body corner posts and are the new Pennsylvania standard design for suburban passenger service, with some slight modifications in the vestibules and other details to permit the installation of the electrical equipment.

On account of the increased traffic in the electric zone during the summer months, about 25 to 3 per cent more cars are needed than are in service during the remainder of the year. To take care of this increase, first, 20 steel trailers were built in 1915, 25 more in 1916 and 45 in 1917.

To keep down both the weight and the cost, it was decided to build as light weight a car as possible, but, at the same time, secure a maximum carrying capacity and therefore reduce as far as possible the investment tied up during the winter season. On further investigation, it was found that three trailers could be built for about the cost of one complete motor car.

The strength of the underframe and body, however, is equivalent to that of the motor cars with which they operate, but their weight was kept down by the use of the arched roof and the omission of the false floor, inside lining and provision for heating. The seating capacity of 80 passengers, with a total weight of 63,000 lb., gives the extremely low weight per seated passenger of 787½ lb., while the weight per seated passenger on the motor cars is about 1550 lb.

On practically the same route miles, the passenger car miles increased from 12,500,000 in 1913 to 17,8000,000 in 1919, due largely to the cantonments built on the island during the War.

Electrification of the Southern Pacific's Oakland, Alameda and Berkeley Suburban Lines

This improvement was a part of the great rehabilitation of Southern Pacific property carried on by Mr. Harriman. In the fall of 1906 instructions were given to begin electrification.

At the present time more than 900 electric trains are operated daily from the two ferry landings, and approximately thirty-two million passengers are handled annually.

The trains of from one to seven cars are operated by the Sprague multiple unit system, a train unit consisting of one motor and one trail car; the motor car carrying four 140 h-p. motors. The two motors on each truck are connected permanently in series, so that, although the equipment is a four-motor equipment, the control is of the usual two-motor type.

The total single-track mileage electrified is about one hundred, and the car equipment consists of:

60 trail coaches
50 straight motor coaches.
29 passenger and baggage motor coaches.
2 express and baggage motor cars.
10 street cars.

The system was placed in operation in the summer of 1911.

Discussion

In introducing this report, Mr. Pilcher of the Norfolk & Western commented as follows on the salient features of the subject:

Anyone who will undertake to look through the report will find that a great many different schemes have been studied for the purpose of developing this phase of railroad traction. He will also find that each member of the committee has given mainly the facts of electrification with reference to the service on his own line, and anyone reading the paper will be given an opportunity to select the matters which are of particular interest to him, according to the conditions under which he has to study his problem, and in this way enable him to choose that which is best for his particular condition.

The art of electric traction in very heavy service is a development of the last few years only. It probably seems destined now to become a greater and greater factor in railroad operation.

One of the things which will impress you with electric traction is the possibility of constant speed for every train running on the line, one following the other, and in this way increasing very largely the capacity of the track because of the fact that one train is not getting in the way of the other. We all have in our minds the wonderful carrying capacity of heavy buckets; although each one of them carries not a great deal in itself, the operation is continued, and one bucket does not get in the way of another, and this feature with regard to electric traction will impress any of you who study the problem of electric traction—the large increase in the carrying capacity of the railroad, due to reliable and constant speed of operation, whether up-grade, down-grade, or on the level—one train will not catch the other, and each train will move with certainty.

Chairman Tollerton: The report is now open for discussion. It is a pretty important question in view of the water power bill that recently passed Congress. One of these days a lot of us will be running electric locomotives who are not running them now. This is an important aid to conservation, when you take power out of the streams and not out of the ground.

C. F. Chambers (C. of N. J.): I move that the report be received and printed in the minutes, and also that the committee be thanked for the very excellent report which it has presented. I think few of us realize the importance of electric power as it is being developed to-day on some of the dense traffic districts and mountain roads.

This motion was duly seconded, and carried.

Scheduling and Routing Systems for Locomotive Repairs

SCHEDULING AND ROUTING in railroad shops is not new. The first schedules recorded were used in the Chicago & North Western shops in 1904. These consisted simply of working sheets and assigned dates made out and followed up by the shop supervision. Since that time more than 15 railroads have adopted some form of schedule system for repairing locomotives, all of which are more or less alike in basic principles.

Briefly, the locomotive is brought to the shop on a predetermined date or order, the tank disconnected and the engine forwarded to the stripping pit. Stripping is handled by a special gang in charge of a leader, and all parts are delivered to the proper departments of the shop. Predetermined dates are then assigned for completing the parts in time to assemble the engine in the best practical and logical sequence. These dates are obtained from master schedules which are compiled for each class of repair and for varying numbers of days required to complete the engine. All delays of material or operations are checked daily, and foremen are notified of the delays in their departments. No definite time is given in which operations shall be performed; it is only necessary that the work shall be finished on a certain day or date. The result of scheduling the complete capacity of the shop will automatically develop for each operation a stated number of hours which will very closely approximate the minimum number of hours in which that operation can be performed.

The following items cover the necessary steps to be taken for

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EDITOR'S NOTE—For descriptions of specific installations, see the *American Engineer and Railroad Journal* for May, 1905, page 159; the *Railway Age Gazette, Mechanical Edition* for August, 1913, page 423, and November, 1914, page 588, and the *Railway Mechanical Engineer* for April, 1918, page 219, and June, 1919, page 320.

installing an adequate scheduling and routing system as now in operation on some railroads:

1—Supervisor of shop schedules and assistant.
2—Schedule office for the supervisor.
3—Schedule and planning boards.
4—Shop or job blackboards.
5—Printed forms, master sheets, etc.
6—Calendar slide rules.

This list may be modified for smaller shops, but as the general methods and principles are the same, the above installation will be described. It is not advisable to introduce this system where less than 10 locomotives per month are given classified repairs.

It is also inadvisable to employ these methods in roundhouses and shops making heavy running repairs exclusively.

PITTSBURGH & LAKE ERIE RAILROAD
ERECTING SHOP

Engine No.....
Class Rep's.....
Date In.....
Date Out.....

.....Foreman

CLASS OF WORK	Date Wanted	Date Finished	MATERIAL	Wanted from Machine Shop
Engine in Shop Unwheeled			Frames or Tongues	
Engine Stripped Material Delivered			Rockers and Boxes	
Boiler off or Stripped			Cylinder Bushings	
Superheater Units Out			Valve Bushings	
Flues O. K.			Braces, Pads and Waist Sheets	
Smoke Box Work			Engine Truck Parts	
Stay Bolts			Engine Truck Wheels	
Flue Sheet			Spring Rigging Parts	
Side Sheet and Crown Sheet			Boiler Fittings, Air Pump and Parts	
Ash Pan and Grates			Motion Work	
Boiler Tested			Cross Heads	
Saddle Bolts and Boiler Waist Sheets			Main and Side Rods	
Frame Braces and Pads O. K.			Piston and Valve Packing	
Frame and Cylinder Bolts			Throttle Valve and Parts	
Cylinders Bushed or Bored			Driving and Trailer Boxes	
Valve Seats Planed or Bushing Bored			Pistons and Rods	
Shoes and Wedges and Binders O.K.			Valves and Yokes	
Spring Rigging Up			Steam Pipes and Dry Pipes	
Guides Lined			Driving and Trailer Wheels	
Motion Work Up			Eccentrics and Straps	
Engine Truck O. K.			Engine Brake Rigging Parts	
Boiler Fittings, Air Pump and Parts			Steam Chest and Cylinder Heads	
Steam Pipes and Throttle Valve In			Frame and Cylinder Bolts	
Boiler Lagged			Guides and Knees	
Engine Wheeled			Shoes and Wedges and Binders	
Boiler Jacket O. K.				
Cab and Running Boards O. K.				Wanted from Smith Shop
Superheater O. K.			Frames and Tongues	
Main Rods Up			Braces or Pads	
Velvet Set			Rocker Arms or Guides	
Boiler Trimmings O. K.			Spring Rigging Parts	
Pipe Work O. K.			Engine Brake Rigging Parts	
Brake Rigging O. K.			Engine Truck Parts	
Side Rods O. K.			Binders and Yokes	
Eng. Despatched			Tender Parts	

.....General Foreman

Fig 1.—Erecting Shop Operation Sheet

1—The supervisor of shop schedules should be a man with practical experience, capable of handling men and with sufficient technical education to make clear reports and records; preferably a man who has served an apprenticeship and is familiar with all trades.

He should report to the superintendent or assistant superintendent of shops. At large shops an assistant may be required.

2—The schedule office should be located conveniently with respect to the machine and erecting shops, preferably in the office of the general foreman or opening from it. A room 10 ft. by 12 ft. will be sufficient but should be larger if possible. It is important to have this office so located that the supervision can frequently confer with the schedule supervisor and have ready access to and examine the records on the schedule boards.

3—Schedule boards are made to suit local conditions and should be about 36 in. by 58 in. or smaller. Two boards are necessary, one for the current month and one for the following month, continuing in succession from month to month. The planning

OUTPUT OF_____SHOPS

MONTH OF_____191__

Schedule Office

CLASSIFIED REPAIRS

NUMBER OF ENGINES		TOTAL NUMBER OF ENGINES			TOTAL DAYS IN SHOP		AVERAGE DAYS IN SHOP		AVERAGE DAYS PER ENGINE	
Scheduled	Carried Over	Early	On Time	Late	Schedule	Actual	Schedule	Actual	Early	Late

Total engines despatched _____
Percent of total engines scheduled _____
Number of engines rescheduled _____
Percent of total engines on time and early _____
Average number of delays per day _____

HEAVY RUNNING REPAIRS

NUMBER OF ENGINES		TOTAL NUMBER OF ENGINES			TOTAL DAYS IN SHOP		AVERAGE DAYS IN SHOP		AVERAGE DAYS PER ENGINE	
Scheduled	Carried Over	Early	On Time	Late	Schedule	Actual	Schedule	Actual	Early	Late

Total engines despatched _____
Percent of total engines scheduled _____
Number of engines rescheduled _____
Percent of total engines on time and early _____
Average number of delays per day _____

OUTPUT

Class 1 repairs _____
" 2 " _____
" 3 " _____
" 4 " _____
" 5 " _____
Total _____
Heavy running repairs _____

COPY TO

S. S.
M. M.

Fig 3.—Monthly Report

board is used for assigning engines to the shop to adjust the class of work to the organization and particularly to avoid overloading any department. This board simplifies the work of the schedule supervisor.

4—Small blackboards are used for conveying the dates the work is due finished directly to the man on the job. These blackboards may be employed to the extent of 15 or 20, as may be found desirable. Foremen of gangs, or departments, are expected to keep up these blackboards, crossing out engines and dates when the work is completed and delivered.

5—About 20 forms are used for operating this system to best advantage. These forms cover the constant or master schedules, delay sheets, check sheets and shop sheets used for conveying dates directly to the departments interested. All forms, excepting master schedules, should be printed.

6—The calendar slide rule is indispensable for transferring the constant intervals of time on the master schedules to actual dates on the shop sheets. By the use of this simple device a large number of dates can be assigned quickly and one setting of the rule is sufficient for one schedule on an engine.

The above discussion contemplates only the handling of the locomotive and its parts after arriving at the shop and is not directly concerned with the assignment of engines to the shop

and their selection for repairs. But this feature is important and has a decided bearing on the success of the system. Overloading departments with too much boiler work or too many broken cylinders or frames will result in delays and prevent schedules based on evenly apportioned work from operating effectively. The shop superintendent should have absolute control over engines to be repaired, as he is in the best position to adjust the incoming work to his organization and to the work being performed in the shop.

It is, perhaps, not pertinent to this discussion to treat at length the subject of proper inspection of incoming engines, although this matter has considerable bearing upon successful operation. One railroad has the matter of complete and careful inspection and examination of incoming engines developed to a considerable extent. A chief inspector is assigned, with one or more assistants, to go over the engine with a surface examination before stripping and during dismantling. These men select all of the parts to be removed and make out regular inspection forms, giving sizes of all fits, clearances and tolerances for renewals and repairs of these parts. They use micrometer calipers, giving all dimensions in decimal parts of an inch, reading to thousandths, thereby insuring correct and accurate fitting and alignment. This practice results in less movement of parts from one machine to another for fitting, also considerably less movement of men or foremen from one shop to another and discussion between them as to methods of making the repairs in question. Less spoiled work, standardization of parts and a prolonged life of engines will also develop.

The practical operation of the scheduling and routing system may be described as follows: An engine awaiting shop is thoroughly examined by boiler and machinery inspectors who make report as to condition. One copy of this report goes to supervisor of shop schedules, enabling him to define the classification of repairs needed and assign the proper schedule and number of working days required for completing repairs. The engine is next forwarded to the stripping pit and an itemized list of repairs needed is then forwarded by pit inspectors to supervisor of shop schedules, who is then in a position to assign exact dates and issue sheets to all departments concerned. These dates are posted by the supervisor on the schedule boards. At least once a day the supervisor and his assistant visit each foreman with the check sheets and examine the work which they have record is due or delayed on the engines under repair in the shop on that date. Returning to the schedule office a daily sheet is made out and issued to the supervision, calling their attention to the material and operations delayed, the number of days delayed in the schedule and the cause. These delays are then posted in red ink on the schedule boards where foremen and workmen can see quickly how their department stands and determine the status of their delays for the month. An excessive number of red marks in any one vertical column on the schedule board indicates forcibly that this job or department, represented by that particular vertical column, is probably the cause for delaying the engine. The supervisor of schedules has other duties, such as preparing weekly output sheets, reschedules, statements for higher officers and other reports and charts as requested. Comparative records are valuable for stimulating interest and keeping departments alive to the fact that they are falling behind and causing delay to the work in the entire shop.

The benefits derived from the use of these scheduling and routing methods are considerable. Schedule boards indicate infallibly where delays periodically or persistently occur and

SCHEDULE CONSTANTS—LOCOMOTIVE SHOPS.

ERECTING SHOP — Foreman

Operations	Date Wanted
Engine in shop unwheeled	1
Engine stripped, material delivered	2
Flues out	3
Staybolts and radials out	6
Frames and Cylinders bolted	11
Cylinders bushed or bored	12
Shoes and wedges laid off	12
Spring rigging up	13
Flues set	13
Guides lined	13
Staybolts and radials in.	13
Engine truck O. K.	13
Boiler fittings O. K.	14
Boiler tested	14
Engine wheeled	14
Steam pipes in.	15
Cab and runs O. K.	15
Boiler lagged	15
Boiler jacket O. K.	15
Motion work up	16
Valves set	16
Main and side rods up	17
Ash pan and grates O. K.	17
Smoke box work and superheater O. K.	17
Engine brake rigging O. K.	17
Pipe work O. K.	18
Engine dispatched	18

Material	Wanted in Machine Shop	Wanted from Machine Shop
Cylinder bushings		11
Engine truck wheels	2	11
Spring rigging	2	11
Boiler fittings	2	12
Cross-heads, guides and blocks	2	12
Steam pipes	2	13
Motion work, eccentric and straps	2	13
Driving and trailer wheels and boxes	2	13
Shoes and wedges	12	13
Engine brake rigging	2	15
Valves and yokes	2	15
Pistons and rods	2	16
Main and side rods	1	16

Material	Wanted in A. B. Shop	Wanted from A. B. Shop
Engine brake equipment	2	14

MACHINE SHOP — Foreman

Class of Work	Wanted from Erecting Shop	Wanted from Smith Shop	Wanted in Erecting Shop
Cylinder bushings			11
Engine truck wheels	2		11
Boiler fittings	2		12
Steam pipes	2		13
Driving and trailer wheels and boxes	2		13
Shoes and wedges	12		13
Valves and yokes	2		15
Pistons and rods	2		16
Spring rigging	2	9	11
Cross-heads, guides and blocks	2	9	12
Motion work, eccentric and straps	2	10	13
Engine brake rigging	2	11	15
Main and side rods	1	12	16

BOILER SHOP — Foreman

Class of Work	Wanted O. K. in Erecting Shop	Wanted in Smith Shop
Flues	11	3
Flue lengths		6
Flues, set	13	
Patches or fire box sheets	12	
Staybolts and radials out	6	
Staybolts and radials in	13	
Boiler tested	14	
Smoke box work and superheater	17	
Ash pan and grates	17	

PIPE, TIN AND AIR BRAKE SHOP

Class of Work	Wanted from Erecting Shop	Wanted in Erecting Shop
Engine brake equipment	2	14
Jacket	2	16
Pipe work	2	18

CAB AND TENDER SHOP

Class of Work	Wanted in Tender Shop	Wanted O. K.
Tender	5	14
Cab		15
Lagging		15

SMITH SHOP — Foreman

Class of Work	Wanted from Erecting Shop	Wanted in Machine Shop	Wanted in Erecting Shop
Binders	2		9
Flue lengths	6		
Flues	3		11
Spring rigging	2	9	11
Guides and blocks	2	9	12
Motion work	2	10	13
Engine brake rigging	2	11	15
Main and side rods	1	12	16

PAINT SHOP — Foreman

Class of Work	Wanted O. K. for Paint	Wanted Painted
Cab	15	17
Tender	14	17
Engine	16	18

Days allowed	18
Class repairs	3

H. G.
Total 130.—R. W.

Fig 2.——Constant Sheet or Master Schedule

such departments may be built up or strengthened. Under the piecework plan this system has resulted in men making more money on account of receiving material more promptly. Under the day work plan the system acts as a stimulant and to some extent takes the place of interest in the work automatically removed through abolition of piecework methods. Friction between departments is almost entirely eliminated. It is not possible to unload on one department causes for delay which belong to another.

This system to some extent establishes tasks or jobs. Every conscientious foreman or workman likes to have certain work to perform in a stated time and to feel confident that this is exactly what is wanted. Each schedule date delivered to the foreman or workman becomes a written order to that man to deliver the work on that date. Unnecessary driving will be brought to a minimum. Dates are assigned, and if the work is

BALTIMORE AND OHIO RAILROAD

M. P. DEPARTMENT—SCHEDULE OFFICE

_____S. S.

DAILY DELAY SHEET _____191—

_____G. F.

MACHINE SHOP	Engine Number	Days Late	Cause of Delay	SMITH SHOP	Engine Number	Days Late	Cause of Delay
Frames or Tongues				Frames or Tongues			
Rockers and Boxes				Braces, Pads and Waist Sheets			
Cylinder and Valve Bushings				Binders			
Braces, Pads and Waist Sheets				Flue Lengths			
Engine Truck Wheels				Flues			
Steam Pipes				Rockers and Boxes			
Spring Rigging				Spring Rigging			
Boiler Fittings				Tender Parts			
Driver Brake Fulcrums				Guides and Blocks			
Motion Work				Motion Work			
Crossheads, Guides and Blocks				Engine Truck Parts			
Driver and Trailer Wheels and Boxes				Engine Brake Rigging			
Shoes and Wedges				Main and Side Rods			
Pistons and Rods				TENDER SHOP			
Valves and Yokes				Tender O. K. for Paint			
Main and Side Rods				Cab O. K for Paint			
Engine Brake Rigging				PAINT SHOP			
Eccentrics and Straps				Cab			
BOILER SHOP				Tender			
Patches or Firebox Sheets							

SIGNED_____

Fig 4.—Daily Delay and Check Sheet

done on these dates no criticism or censure is necessary. The constant reappearance of the daily delay report stimulates foremen and workmen to better purpose than criticism.

A visit to shops where this system is in operation brought out unanimously favorable comment from superintendents and foremen relative to its operation. The general foreman's duties are greatly simplified. Heretofore he might go from one department to another trying to fix the responsibility for delays. No system can take the place of foremen, but this system can eliminate a large amount of traveling by the supervision from one department to another.

No definite figures are possible giving the saving in money resulting from the use of these methods. We may, however, consider one saving from the standpoint of the potential value of the power. Assuming that the service of a locomotive is worth, on an average, $50 a day and that one day is saved in the time each engine is held on the pit, the money saving in a shop having 25 pits and delivering two engines per pit per month, would be $2,500 per month, or $30,000 per year. This statement is based on the assumption that quicker deliveries of power are directly attributable to the methods described in this paper. Other savings, including labor, material, overhead, etc., will always result from more systematic operating methods.

The system can also be used in passenger and freight car repair shops and recommends its wider installation in locomotive repair shops.

The report was signed by Henry Gardner (Chairman), Baltimore & Ohio; S. W. Mullinix, Chicago, Rock Island & Pacific; D. J. Mullen, Cleveland, Cincinnati, Chicago & St. Louis; H. H. Maxfield, Pennsylvania System; C. J. Bodemer, Louisville & Nashville; John Purcell, Atchison, Topeka & Santa Fe; R. J. Williams, Pere Marquette, and A. A. Burkhart, New York Central.

Discussion

Henry Gardner (B. & O.): I understand that the New York Central and Michigan Central have been very successful in scheduling their system of car repair shops, and, if consistent, I would like to hear from some gentleman present on that proposition.

W. H. Flynn (M. C.): I am not qualified to speak with authority, but I will say that since we have installed this system for the locomotive shops the benefits derived from it are very noticeable, and I can heartily recommend the system to anyone who is not now using it. We have found that in addition to the advantages of scheduling the locomotive and following the work through that the meetings of foremen three times a week, after the conclusion of the day's work, are most beneficial in getting the men together. Of course, they have their little tiffs, etc., but it is all friendly, and they go back in the morning with renewed vigor and a determination to hold up their own department.

We have also found that in the routing system great advantages are attained in getting the work to the workmen and also in taking away the finished work as soon as completed. No man works as well when he has a lot of finished work laying around his machine as he does when it is taken away promptly. When it is taken away currently he realizes there is a necessity for the work and somebody wants it. We take the work and lay it either close to the engine or some place else, but in any event it is taken away from the workmen. If there is anybody who has not started a routing system, there is no better time to begin than when you go back home. It cannot be equalled under the present working conditions.

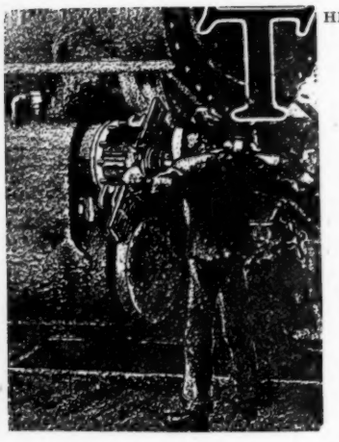
Mr. Burkhardt (N. Y. C.): We have had this system in effect at West Albany to some extent, but never on a very elaborate scale. But I know that New York Central Lines West are carrying the idea along and are having good success with it and they claim it is very successful.

Mr. Gardner: I have known of some of the railroads that are using this schedule system. I could mention the B. & M., Big Four, Santa Fe, P. & L. E., L. S. & M. S., A. C. L., P. M., M. C., Frisco, B. R. & P., N. Y. C., C. P., Pennsylvania and B. & O. I wish we could extend this to other railroads. I am sure that the scheduling and dispatch system is of great value to the shops, especially since we have abolished piece work. The system automatically takes the place of the interest which was supplied by piece work. I believe that the mechanics understand the system for car repairs as well as for the locomotive shop, and that is why I ask the question in regard to the Lake Shore & Michigan Southern. Mr. Burns, of the Canadian Pacific, has developed the system at his shop, and it would be of interest to hear from him.

C. H. Wiggin (B. & M.): I can thoroughly agree with what the previous speakers have said of this scheduling system. I started it in a brief sort of way at our Hocking Shop as early as '98. It proved quite successful in a small way, and we have gradually elaborated upon it. We feel that it is the nearest approach to piece work that can be established in any shop.

Mr. Goodnow (C. & N. W.): *I would like to move that the committee be continued to make a study of the car department methods, and recommend blanks or forms to take care of that particular branch of the work. This motion was seconded and was unanimously carried. A motion that the report be received and printed in the record was made and carried.*

Report of Committee on Superheater Locomotives



THE COMMITTEE REPORT dealt with the installation, operation, care and maintenance of superheater equipment for locomotives. Before outlining the recommended practice on this subject, the data shown in Table I was submitted with reference to providing swabbing on piston rods. These results do not strongly support the opinion that piston-rod swabbing is essential to good service and, on account of the limited information that has been furnished along this line, the committee hesitates to make recommendation either for or against the use of swabbing.

Installation of Superheater

When parts are received from manufacturers they should be coated with some protective coating and stored under shelter until used. Care should be taken to see that the wooden protection blocks over ends of units and joints in headers are in place and used.

In the installation of the header the perfection of the joints should be thoroughly established, and care exercised to see that the header is placed in a level position before it is finally secured to the boiler. The same care with reference to the condition of the ball joints on the units and their seat in the header should be exercised. It is recommended that all ground joints should be bolted in place, metal to metal, without any medium other than a coating of oil to bring the joints to set without causing any undue friction.

Bolts, either heat treated or of special steel, should be employed in securing the units to the header.

TABLE I

COMPARISON OF SERVICE OF PISTON-ROD PACKINGS AS INFLUENCED BY THE USE OF SWABBING ON PISTON RODS ON SUPERHEATER LOCOMOTIVES

Kind of Packing	ITEMS	Passenger Service 5-in. Diam. Rods Swabbing		Mallet Locomotive H. P. Engine 3¼ in. Diam. Rods Swabbing	
		With	Without	With	Without
	Number of rods equipped..	4	2	3	3
A	Number sets renewed	16	4	3	1
	Average mileage	7,240	20,247	9,002	18,850
	Number of rods equipped..	3	3	3	3
B	Number sets renewed	13	8	3	2
	Average mileage	6,663	8,944	14,004	12,028
	Number of rods equipped..	3	3	3	3
C	Number sets renewed	6	5	7	22
	Average mileage	14,359	18,648	2,384	2,007
	Number of rods equipped..	2	2	2	2
D	Number sets renewed	5	4	9	6
	Average mileage	9,310	8,679	3,503	2,390
	Number of rods equipped..	12	10	11	11
Total	Number sets renewed	40	21	22	31
	Average mileage	8,379	13,357	5,329	3,271

Care should be exercised to see that the operating cylinder is properly located on the damper shaft so as to give the piston sufficient movement to provide the proper opening for the dampers.

In closing the opening around the steam pipe where it passes through the smokebox, a fibrous packing or cement should not be used. A metal covering should be used in such a manner that it can be fastened both to the smokebox and to the steam pipe.

After the superheater and steam pipes are completely placed and hydrostatic test is applied, if any ball joints are found leaking they should be taken out and reground, as tightening a bolt will not repair an imperfect joint.

After superheater header and units, pistons and valves have been applied, the throttle-valve should be blocked down and steam test blown back through the steam chest and superheater units. When these parts become heated, tighten all joints.

When superheaters are installed some provision should be made for supplying a limited amount of steam for use when drifting.

A limited number of pyrometers should be applied to superheater locomotives on each division for the educational value they would possess.

When superheaters are applied to existing equipment the front end door should be made sufficiently large to permit working to advantage in removing or applying units. It is recommended that the clear opening be 42 in. in diameter. This dimension can easily be arranged on new locomotives.

Operation

Locomotives equipped with superheaters should, in general, be operated in the same manner as locomotives using saturated steam. The cylinder cocks should normally be open when the locomotive is standing under steam, and when the locomotive is started they should remain open until dry steam appears. In starting a superheater locomotive, the reverse lever should initially be placed for full travel of the valves, and at all times the water level in the boiler should be such that there will be no possibility of water being carried into the superheater.

Water carried into the superheater will be evaporated into saturated steam or steam with a low degree of superheat, seriously affecting the economics available through proper operation; also water carried into the superheater may flash into steam after the throttle has been closed, placing the locomotive to that extent beyond the control of the engineman. Water carried into the superheater in quantities sufficient to reach the valves and cylinders will remove the lubrication from these parts and may result in knocking out cylinder heads or other damage.

Superheater locomotives should be handled only when the air brakes are in operative condition.

It is essential that the oil supply for the lubrication of the valves and cylinders on a superheater locomotive should be constant, as the high temperature will cause serious damage to these parts if there is an interruption of their lubrication. When locomotives are not equipped with drifting valves the throttle should be slightly open when drifting, in order to avoid the suction of hot gases into the steam chests and cylinders. The position of the superheater damper can be determined by observing the position of the counterweight attached to the damper shaft, and the engineman should know that the damper is wide open when steam is being used.

Care and Maintenance

At regular periods, and preferably when the monthly federal inspections are made, there should be a thorough inspection of all parts which come in contact with the fire or with the products of combustion. There should be a careful inspection for steam leaks, and the entire front end arrangement should be carefully examined.

When the locomotive receives this periodical inspection, each flue in the boiler must be thoroughly cleaned by blowing out with compressed air supplied through a pipe of sufficient length to extend entirely through the flues; the flues also should be cleaned whenever necessary between the periods when the periodical inspections are made.

At the time of the periodical inspection, the superheater damper should be connected to the shop steam or air line, in order that the damper may be operated and the rigging checked for lost motion and the damper opening also checked; it should also be known that the damper piston travels through the full stroke and makes a steam-tight joint against its seat.

The special tools recommended by the Locomotive Superheater Company for installing and maintaining superheaters should be employed.

When, for any reason, superheater units are removed from the boiler, they should be tested before being returned, with a cold water pressure of at least 25 per cent in excess of nominal boiler pressure.

Unit bands and supports should be inspected whenever units are removed, and renewed if necessary, to insure units always being properly supported and in correct relation to the flues.

When replacing superheater units, bolts should be renewed when there is any evidence of deterioration either in the condition of the thread or worn or pitted condition of the bolt. In all cases, a new nut should be applied and used as the pulling nut in setting the unit in place. An old nut can then be applied as a locking feature after the unit has been properly seated.

In regrinding the ball joint of the unit and the socket joint of the header, the original contour of these surfaces should be maintained.

After removal of the units, seats should be protected with a protecting coating and covered to prevent injury to seats and entrance of foreign substances into unit pipes.

All dirt should be removed from the top of the header or tee-bolt slots before the superheater is reassembled.

Lubrication

The committee gave this matter considerable study and, for the reason that there is no definite information available on which to base conclusions, is unable to make any recommendations at this time. The committee proposes, if continued, to further study the subject and outline a program of tests to be followed on several different railroads, the data obtained from these tests to furnish a basis for drawing some definite conclusions as to the relative value of hydrostatic and force-feed lubrication.

Diameter of Piston Valves and Cylinders

The committee also reported as follows on the economical diameter of piston valves of superheater locomotives, with recommendations for standard practice in connection with various cylinder diameters:

This question has been studied at quite some length and a number of roads reported to the committee relative to the dimensions of their leading locomotives for passenger, freight and switching services. Among the items reported were the valve diameter, the cylinder diameter, the stroke of the piston, diameter of drivers, area of steam ports, maximum cut-off port opening at maximum cut-off, and several other items tending to work out a relation between the valve diameter and steam demand of the cylinders.

Among the variables encountered are the travel of the valve, the port openings, the cross sectional area of the various elements of the entire steam passageway between the boiler and the cylinder. By giving this subject a little thought it will be appreciated that no one item can be fixed as long as there are any variables to take into consideration. If such items as port area and valve travel are fixed, then the liameter of a valve can be ascertained that will supply the proper amount of steam for a certain piston displacement.

For the above reasons, the committee is unable to make any concrete recommendations at the present time.

The report is signed by H. R. Warnock (Chairman), C., M. & St. P.; H. W. Coddington, N. & W.; C. H. Hogan, N. Y. C.; R. W. Bell, I. C; W. C. A. Henry, Pennsylvania; G. W. Rink, C. R. R. of N. J.; H. P. Anderson, M., K. & T.

Discussion

C. E. Fuller (U. P.): There is just one part of that report that I do not quite understand.

That is the recommendation for new nuts in repair. I would like to hear from the committee as to that. If they had said a new bolt I would understand it, but I don't understand the new nut proposition.

H. W. Coddington (N. & W.): An old nut may be used in trying to draw the bolt in the joint to a seat, and it was recommended that always a new nut be used in installing a unit, and also, of course, a new bolt, if such was needed. Some roads seem to use those parts over, but the committee wishes to discourage the use of old nuts, unless they are in perfect condition.

C. M. Darden (N. C. & St. L.) I would like to ask the committee if it has any figures (they speak of the water being carried over into the superheater) in regard to the water level at which it could recommend that locomotives be operated.

On the N. C. & St. L. we have found that we can greatly increase the temperature of the superheat in the steam by running at a lower water level. This is as much as 75 deg. between the third gage and the second gage, and 50 deg. between the second gage and the first gage. I would like to ask the committee if it has any figures.

Mr. Coddington: I think what Mr. Darden referred to is the matter of priming, and it would be impossible for the committee to fix any standard of water level for a locomotive. By use of a pyrometer on the locomotive, the effect of the priming is very readily and accurately established. An engine may be running along at a uniform speed and all at once you notice that the pyrometer drops back, and there is only one thing that causes that with the steam pressure maintained, and that is priming, and it would be impossible to adopt a standard, for that is one thing that would have to be watched and corrected by each road for each individual power unit.

G. S. Goodwin (C. R. I. & P.): I note that the committee showed in its recommendations two practices for making the steam pipe joint, where the pipe passes through the smoke arch. I notice that it does not include the pfactice which is standard on almost all engines and also applied by the builders. That is, of a jacket casting on the smoke arch with some sort of packing in it. I notice by the report that it is against that. I would like to have the gentlemen elaborate a little more on why they are against that, and why they favor a connection with two more joints. Certainly we do not want more joints in the steam pipe. We have enough joints to give us trouble now.

Mr. Coddington: As to the inquiries we have had, I will say if any of these gentlemen had been at the Fuel Association convention, they would have heard a lot of talk about the leaking front end, and a good deal of the fault in the leaking of the front end is caused by the packing around the steam pipe where it passes through the smoke arch, and it was with the object of getting away from this condition that the practice as suggested was recommended.

It is true it requires more skill and greater cost to establish such joint as shown, especially the one with the casting secured to the front end, but when it is established it is like a steam pipe joint, it stays established until it is disturbed again, whereas with fibrous packing, if you put it in the morning before the engine reaches its terminal it may be blowing.

Mr. Flanagan (C. & O.): I think we would be glad to have details so that we could judge which practices are best to follow when using packing of different types. I assume that where the good results have been obtained without swabbing, Paxton-Mitchell or Trojan packing was used, which would not hug the rod tightly when drifting with closed throttle, and that it was found best to use swabbing where multi-angular rings were used. On the mountain districts of the C. & O. we have found it necessary to resort to swabs for lubricating the piston rods in order to prevent the packing rings and rods from scoring and heating.

Mr. Coddington: The multi-angular or old U. S. packing was not included, and the manufacturer's name was omitted for obvious reasons, and all four packings shown are packings of modern design, and it was also brought out that this record was established by having different kinds of packing on the same locomotives where one side of the locomotive was equipped with swabs and the other side was not equipped with swabs.

As to the heating of the rods, there is no indication in the report of anyone furnishing information that they had trouble along that line.

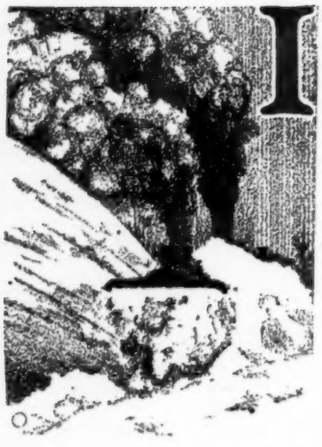
C. E. Fuller: *I move you that the report be accepted and printed in the proceedings and the committee be continued, and their duties extended to the cylinder packing rings for next year's report.*

Chairman Tollerton: A portion of it will have to be referred to letter ballot.

This motion was carried.

Development of Snow Fighting Equipment

By W. H. Winterrowd
Chief Mechanical Engineer, Canadian Pacific



IN A STUDY of snow fighting equipment, it is interesting to note that its development is very largely due to Canadians and to Canadian railways, although snow conditions in Canada are no more severe than those met with on roads passing over the Rocky or Cascade Mountains in the United States.

The well-known Russell design of snow plow was first put in service in 1885 on the Intercolonial Railway, now a part of the Canadian National.

The present rotary snow plow is a development of the invention of a compound revolving snow shovel, patented in 1869 by J. W. Elliott, a dentist of Toronto, Ontario. This elementary device was modified by Orange Jull of Orangeville, Ontario. The Jull rotary was taken up by the Leslie Brothers, also of Orangeville, who constructed a full size model which was tried out in the Parkdale yards of the Canadian Pacific in 1884. The success of this trial led the Leslie Brothers to have made for them a complete plow which was tried out by the Union Pacific during the winter of 1886-87. This plow was the forerunner of the modern rotary.

The principal types of snow fighting equipment may be generally classified as follows: Engine and pilot plows, push plows, wing plows, spreader plows, machine plows, flangers, ice cutters and snow sweepers.

Engine and Pilot Plows

As far as the writer can ascertain, the first snow plow ever built was of the push plow type. This was a wedge-shaped wooden plow mounted on trucks and pushed in front of a locomotive. As this plow derailed frequently, an endeavor was made to take advantage of the weight of the locomotive. A plow was constructed utilizing the front end of the locomotive as a support. Engine plows are still in use today and their general arrangement has not been changed, except to adapt them to larger locomotives. It is usual to apply cast-iron wearing shoes which rest on and slide along the top of the rail if the weight and force of the snow cause a depression of the nose of the plow. Several railways have advised that occasionally engine plows are permanently secured to the front of a locomotive assigned only to plow service, thus making a complete unit available at any time. For severe work this locomotive may be assisted by others.

The pilot plow was developed for use in light snow. It usually consists of mold boards of steel plate securely fastened in front of and over the pilot, and braced to the front bumper and smoke box. In moderate snows which do not pack hard or drift, and where the railway is free from deep cuts, and train operation is fairly frequent, engine and pilot plows are of great assistance in maintaining an open line.

Push Plows and Wing Plows

A push plow is a self-contained unit consisting of a substantially built car with a wedge-shaped plow attached to its front end. This plow is generally pushed by one or more locomotives. The car may be fitted with flangers for cleaning the space between the rails. When the car is equipped with wings for widening the cut it is called a wing plow.

Push plows were frequently built V-shaped, simply throwing the snow to each side without lifting it appreciably. These plows did not always prove satisfactory, as the snow was crowded aside, and if drifts were deep or in cuts it fell back on the track after the plow had passed. In hard drifts this plow packed the snow. In heavy side drifts the form of the plow tended to derailment. Also, when backing, unless shields were applied, snow was picked up on the back of the mold plates and carried into the trucks.

The square-nosed plow was developed to overcome these objections. The front of this plow consists of two wedges. The main, or bottom wedge, with its cutting edge horizontally across the track, is a plane inclined upward and backward. Its purpose is to lift the snow. The upper, or vertical superimposed wedge, is set some distance back from the front edge and is either V-shaped for single-track operation, or triangular for double-track operation. The upper wedge throws clear of the track the snow which has been lifted by the bottom wedge.

Many modern plows of this type have an additional feature known as the drop nose. This consists of a plate hinged to the front of the bottom, or lifting, plane in such a manner that it may be brought down between the rails, removing the snow to a depth of two or three inches. The nose is ordinarily operated by either hand levers or by compressed air cylinders controlled from the cupola of the plow.

Russell Plow

One well-known push plow is the Russell design. This plow is of the square-nosed type and is generally built of strong timbers reinforced with structural steel. The framing on which the mold boards are laid has as its main feature a heavy timber called the "back-bone." Power is applied directly to the front of the plow through a steel reinforced timber bar, hinged or pivoted to the "back-bone." This bar extends between the two center sills the entire length of the car frame. At its rear end the coupler is attached. A 4-in. clearance on each side of the bar permits sufficient lateral movement for adjustment on curves. This method of transmitting power directly to the front of the plow is said to be responsible for the claim that Russell plows are seldom derailed. On account of the heavy pressure on the front of the square-nosed plow, the Russell design is fitted with a front truck which has journal bearings on each side of each wheel. Each axle, therefore, has four journals.

The wings of the Russell plow are of the elevator type. The face of each wing is formed into two concave chutes called elevators. These chutes slope upward at an angle of approximately 30 deg. This type of wing first loosens the snow at the side of the cut and then carries it up and out. The distance the snow is thrown depends upon the speed at which the plow is traveling. These wings are forced out into position by means of gearing operated within the car. When not in use these wings fit into recesses in the side of the car.

Canadian Pacific Steel Plow

For many years the Canadian Pacific has constructed its plows of steel. It was the first railway to build and use an all-steel plow. The service given by this type has been very satisfactory. The all-steel plow has a number of advantages, including greater strength, lower maintenance cost, and it affords greater protection to the men operating it. These steel plows have been built for both single and double track operation, and are equipped with drop nose, wings, and in some instances with ice cutters and flangers similar to those applied to rotary snow plows, all devices being controlled from the cupola. Two styles have been built. The type shown in Fig. 1 is used in territory where light, dry snows are frequent. On this type the roof extends forward over the mold plates to prevent snow flying upward. The other type does not have the extension roof and is used where the snows are usually wet and heavy.

Trucks.—The rear truck is of the standard arch-bar freight type, with 33-in. diameter cast-iron wheels mounted on 4¼-in. by 8-in. M. C. B. axles. It is equipped with Simplex truck bolsters, M. C. B. coil springs and roller side bearings. The wheel base is 5 ft., 3 in. The front truck is a special design of arch-bar type, with 28-in. diameter steel-tired wheels mounted on 5-in. by 9-in. M. C. B. axles. Simplex truck bolsters are used, the ends of which are fitted with a combination roller and wedge lateral motion device. This truck has no springs, the space usually occupied with springs being fitted with a wooden block.

The first front trucks used under these plows had no lateral motion arrangement and the wheels were mounted on engine truck axles with inside journals. The bearings and boxes were, therefore, practically inaccessible, except when the plow was standing over a pit. This resulted in numerous hot journals. Occasionally the arch bars bent sidewise, indicating the need of some lateral motion to prevent excessive side strain when plows were passing through sharp curves and guided by the flanged wearing shoe. The present truck with outside journals and with lateral motion device has overcome these troubles.

Draft Attachment.—The rear end is equipped with draft gear. At the front a standard pilot coupler is supported in a large steel casting riveted to the sloping front of the plow.

Underframe.—The center sills consist of two 15-in., 33-lb. rolled steel channels with top and bottom cover plates. The side sills are 15-in., 33-lb. channels. The bolsters are box sections, consisting of pressed plate diaphragms with top and bottom cover plates. Approximately six feet back of the center of the

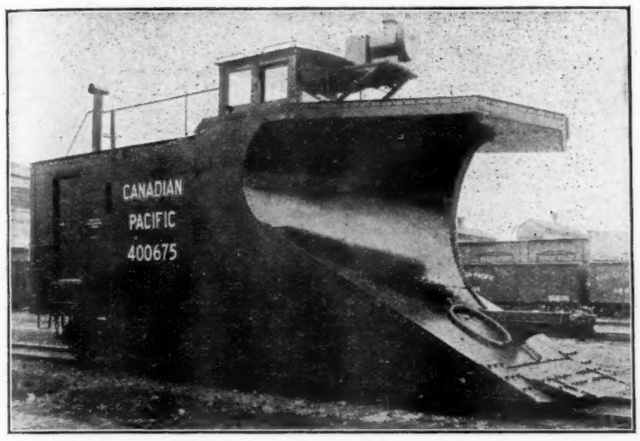


Fig. 1—Canadian Pacific Single Track Steel Snow Plow

front truck is located a very strong cross strut consisting of two 15-in., 22-lb. channels applied horizontally to the top and bottom of the center sills. The strut extends entirely across the plow.

Front End Frame.—The center end post consists of two 15-in., 33-lb. channels which extend from the top of the center sills at a point just back of the front center plate, to the roof. The center of the bottom, or lifting wedge, is supported by two 10-in., 20-lb. channels riveted to the front end of the center sill channels, and to the center end posts. The sides of the lifting wedge are supported by two 10-in., 20-lb. channels. These are supported by the front bolsters and extend diagonally upward and towards the rear to a point near the roof and about midway between the trucks. The roof extension, or hood, is built up of 3/16-in. steel plate, braced with 7-in., 9¾-lb. channels.

Side and End Construction.—The sides and ends are constructed of 3/16-in. flat steel sheets reinforced by angle iron braces and posts. Attached to the side frames are heavy corner angles extending from the bottom of the side sills to the top of the side plate.

Drop Nose.—The drop nose consists of a heavy plate carried on large cast-steel hinges. The front edge is equipped with removable flanged rail shoes provided with hardened steel wear plates. Adjustable cutter plates which extend down on either side of, and between the rails, are bolted to the front edge of the nose. These plates are beveled to a sharp edge and are applied in a number of narrow widths so that sections can be renewed if damaged. The drop nose is operated from the cupola by means of an air operated toggle arrangement placed under the nose frame.

Wings.—At the back edge of the side plates, steel extension wings are attached by means of four heavy steel hinges. The width of plow over sides is 10 ft. The width over ends of wings when fully extended is 16 ft. When folded these wings are flush with the side of the plow. The outer edges of the wings are provided with a beveled extension about four feet in height. When the wings are folded this beveled extension fits snugly against the body side sheet and extends under the side sill as far as proper clearance for the rear journal box will permit. This beveled extension prevents snow from gathering when the plow is backing up. A hasp and staple arrangement secures the wings in closed position when the plow is not in service.

Spreader Plows

The simplest form of spreader consists of a flat car with wings attached to each side, the wings being operated from the floor of the car by means of levers. In house car spreaders the drop wings are usually raised and lowered by air cylinders. The side wings are supported by jib cranes hinged to the side of the car and are held in working position by means of heavy bar braces. On some plows these braces are moved into working position by means of air cylinders. Some types of spreaders are equipped with drag wings hinged to the back corners. This type of spreader is used by some roads to widen cuts after a plain push plow has passed. When widening cuts these wings are in such position that they serve as snowbank cutters, and snow is carried in toward the center of the track, from which it can be thrown by either a wedge plow or a rotary. When equipped with drag wings these spreaders are often called cut wideners.

The large side wings, when extended to their full width, have a total spread of approximately 30 ft. The snow is first cut by the V-shaped plow and, after it is thrown or pushed to one side, the long wings push it out still further. This type of plow is

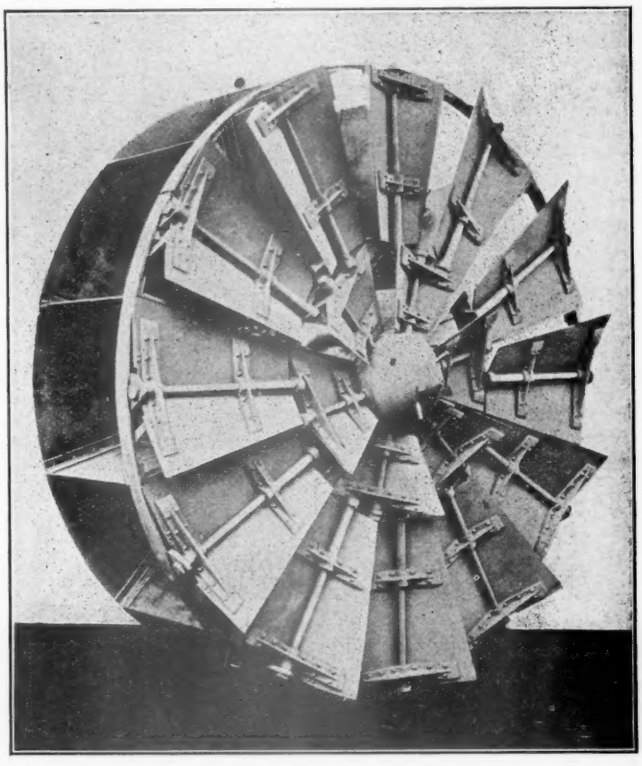


Fig. 2—Improved Fan Type Wheel

frequently used for cleaning up yards. Some roads utilize their ballast spreaders for this purpose.

Machine Plows

On roads which have to fight deep drifts, snow slides, or other conditions beyond the capacity of push plows, the rotary machine plow is used, and to date is the most effective instrument that has been developed for the purpose. These plows can work their way through deep cuts and slides where it would be impossible for any type of push plow to lift the snow and, in addition, can throw the snow clear of the track. If the snow is much higher than the top of the casing it is only necessary to loosen it and throw it down in front of the plow in order to have it picked up and thrown clear of the track.

J. W. Elliott was the original inventor of the rotary principle. His invention was improved by Orange Jull, who applied a knife or cutting wheel in front of the Elliott fan wheel. In 1883 the

Leslie Brothers built the first rotary embodying the Jull modification. The fan wheel was mounted on a hollow shaft in which revolved a solid shaft supporting the knife wheel. The fan and cutting wheels were revolved in opposite directions by means of a gear system.

During the winter of 1883-84, the Canadian Pacific gave this model a trial at Parkdale, Ontario. This preliminary trial, in which snow and ice were thrown over 300 ft., demonstrated the practicability of removing snow with a revolving wheel. This trial, however, indicated that the plow should be constructed so that snow could be thrown to either side of the track and that a flanger was necessary to prevent derailment in hard snow and ice and to leave a satisfactory rail after passing.

To overcome these objections the Leslie Brothers developed a wheel with manually reversible knives which could be changed in position to enable them to cut in either direction. They also applied a movable hood to the cylindrical portion of the casing through which snow could be thrown to either side of the track. In addition they designed an ice cutter, and a flanger, which were applied to the front truck of the plow.

A plow containing these improvements was built for them by the Cooke Locomotive Works of Paterson, N. J. This plow was put in service on the Chicago & North Western during the winter of 1885-86. It is interesting to note that the engines of this plow were equipped with Walschaert valve gear. One difficulty, however, was experienced. The friction caused by the snow passing between the knife wheel and the fan wheel absorbed more power than that required to cut and throw away the snow. The principle of opposite revolving wheels was then abandoned and the Leslie Brothers designed a single fan wheel with adjustable cutting edges. These cutting knives were attached directly to the wheel and automatically reversed their position as the direction of rotation was changed.

The Cooke Locomotive Works rebuilt the plow, embodying these improvements, and during the winter of 1886-87 it was put into service on the Union Pacific. The operation was so successful that the railway company not only purchased it, but three others in addition.

In Canada, in 1888, the Canadian Pacific built eight of these plows, applying a fan wheel which had been still further improved by the Leslie Brothers. This wheel is shown in Fig. 2.

The first rotary plows with the improved Leslie wheel were equipped with a 17-in. by 24-in. two-cylinder engine. Steam was supplied by a locomotive type boiler having 1,259 sq. ft. of heating surface and carrying 180 lb. pressure. The cutting wheel was supported by an 8½-in. diameter shaft geared to the engines. The shaft was supported in a main bearing 34 in. long.

These snow plows, as well as many other early rotaries, were equipped with a wheel of the fan type, Fig. 2. When the plow was in operation the revolving knives cut the snow and delivered it into the space between the partitions. The snow was then carried around the casing until the top opening was reached, through which it was thrown in a straight line by centrifugal force. In light and dry snow the wheels as shown were satisfactory, but in heavy work their construction proved inadequate. This fan type wheel is still in service on very many railways. It is the opinion of most users, an opinion endorsed by J. S. Leslie, that a well constructed, heavily built fan type wheel is the most efficient snow remover that has yet been devised.

The Leslies also developed the scoop type of wheel to handle the soft, fluffy, wet snow found on the Pacific slope near the citrus belt. Such snow had a tendency to adhere to and clog the partitions of the fan type wheel. The wheel is composed of the cone-shaped radially placed scoops, the backs of which

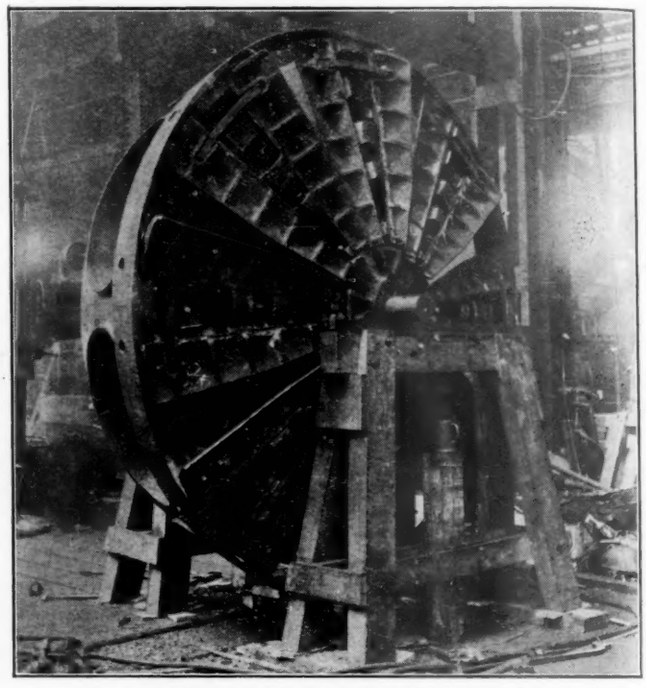


Fig. 4. Canadian Pacific Heavy Rotary Plow—Wheel Being Balanced

are fastened to a steel plate. The surface of these scoops is smooth to prevent the snow from adhering. Each scoop is open its entire length on the front side. A cutting knife is hinged on each side of the opening. These knives adjust themselves automatically into cutting position. The knives on the adjacent edges of each scoop are connected by links so that when one knife is cutting snow the other knife is depressed to afford the necessary clearance.

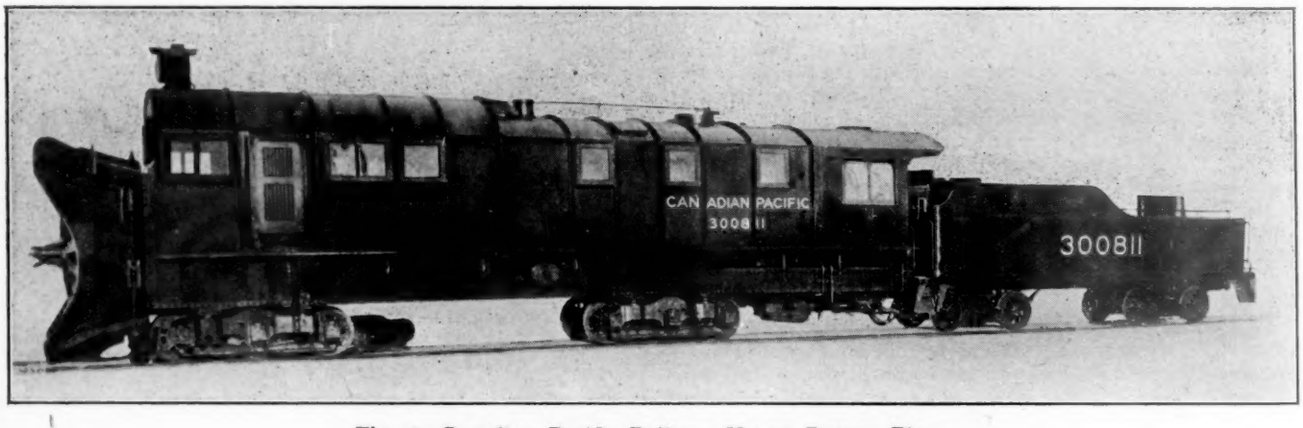


Fig. 3—Canadian Pacific Railway Heavy Rotary Plow

Union Pacific Rotary

On four rotary snow plows rebuilt by the Union Pacific the cutting wheel is built up around a cast-steel center secured in the usual manner to the front end of the wheel shaft. This casting is spool shaped. The front is 50 in. in diameter and contains a number of spokes. On three of these spokes the small center cutting knives are hinged. The outer ring of this center

casting forms the inner ring of the wheel. The outer ring is of mild steel of 1-in. by 4-in. section. Between the inner and outer rings are riveted two types of cast-steel arms. Each alternate arm is provided with bosses for hinging the knives. The front edges of the ½-in. plate partitions are riveted to the arms without bosses. The plain arms also serve as stops for the knives, which are double-edged and of cast steel, and which adjust themselves independently without connecting links. These knives are hinged to the bossed steel arms by means of continuous pins.

A drop nose and substantial cutting wings are fastened to the front casing. When not in use, the wings are drawn in by means of levers operated by a hand screw.

The boilers on these plows are equipped with superheaters. The use of highly superheated steam provides a substantial increase in power and reduces the consumption of fuel and water, enabling the plow to remain out longer without running for an additional supply.

Canadian Pacific Heavy Rotary

The greatest test of a rotary snow plow is its ability to cut through snow slides. The plow can be subjected to no heavier service, a service which is occasionally required on all roads crossing the Rocky, Cascade and Selkirk Mountains. The snow in these slides is not only packed exceedingly hard, but often contains trees and rocks. It is impossible for rotaries to overcome such obstacles. It is generally customary to probe the slide with sounding rods to locate them and, if possible, they are removed by blasting or by being pulled out. Sometimes, however, these obstacles are not discovered, and when the plow encounters them the ordinary cutting knives are generally damaged and the plow often put out of commission. The repair of the knives is generally difficult and slow.

During the winter of 1908-09, Sir George Bury, then general manager of the Canadian Pacific, Western Lines, decided that a plow was needed which would not break down, and he stated that he wished a rotary plow with cutting knives of 2-in. armor plate, and the rest of the plow built in proportion. The following spring authority was given for two such plows and arrangements were made with the Montreal Locomotive Works for their construction. H. H. Vaughan, then assistant to the vice-president of the Canadian Pacific, engaged John Player, consulting engineer of the American Locomotive Company, to prepare the designs in collaboration with him. As a result it was decided to modify considerably the construction of existing plows. It was Mr. Vaughan's idea that better results could be obtained by driving the plow wheel direct in marine engine style, and that the frame of the plow should resemble a bridge girder to thoroughly support the casing or hood. This idea has been justified, as the plows operate with practically no vibration. It was decided to build the plows, incorporating these ideas. The finished plows are shown in Fig. 3, and are the largest and most powerful that have ever been built.

The wheel was made of cast steel. As no facilities were available for machining or annealing a casting of the required size, a built-up construction was used. The center casting was made in octagon form 80 in. across the flats. Eight segments were bolted across the faces of the center casting. These segments follow the curved form of a scoop wheel and have at the outer edges 6-in. diameter bosses for 2½-in. hinge pins. The segments are bolted to the center casting with 2¼-in. bolts. The adjacent segments are bolted together through flanges at their rear edges. A band 1¼ in. thick by 10 in. wide is bolted around the segments, which helps hold them in place. The band is increased in thickness to compensate for the hinge pin and bolt holes, and is made in section with L-shaped lugs on each end which fit into grooves in the segments. The blades are ⅝ in. thick at the cutting edge.

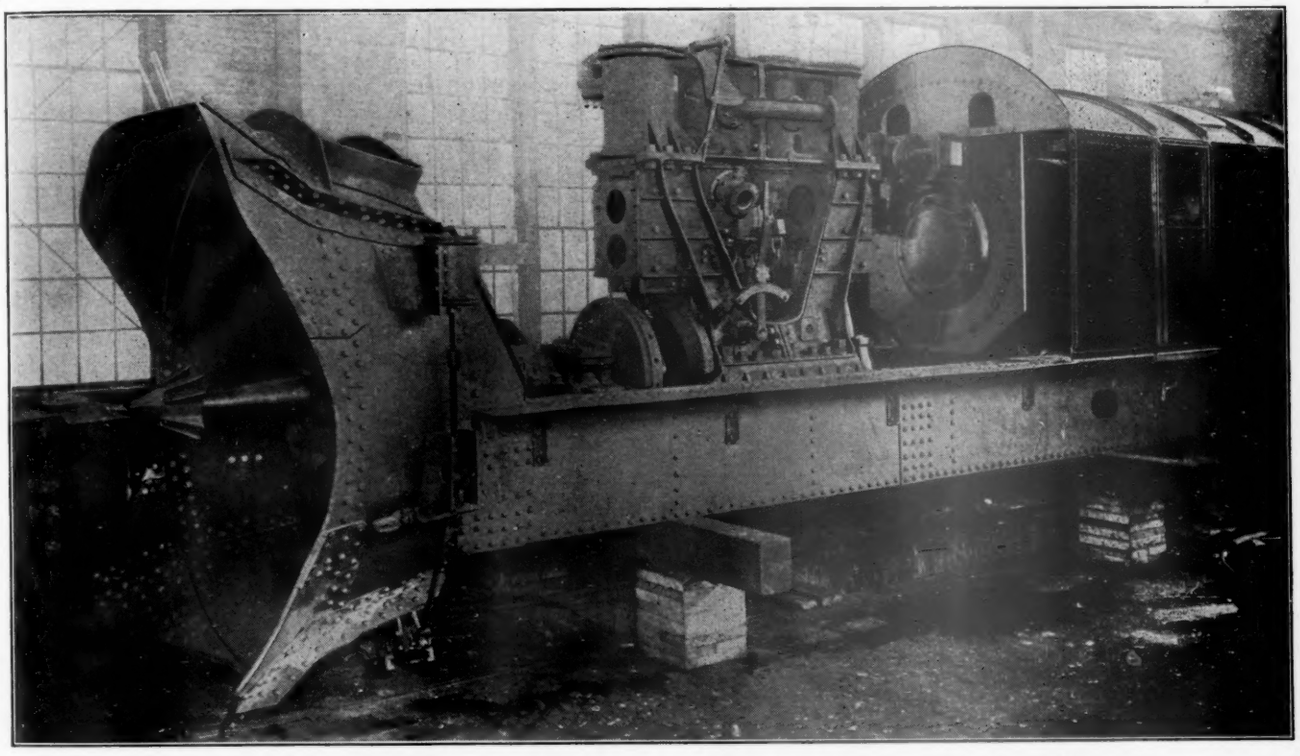


Fig. 5—Arrangement of Engine and Wheel—Canadian Pacific Heavy Rotary Plow

Fig. 4 shows the completed wheel, without the nose piece, being balanced. As shown in this view, the wheel weighed 24,000 lb. and as it was designed to run at 400 r. p. m., it was necessary to balance it accurately.

Fig. 5 shows the arrangement of the engine and plow. The casing is made of ¾-in. plate and tapered to eliminate any flat surfaces on which snow or ice might accumulate. The bottom of the casing is reinforced by an additional ¾-in. plate. The back of the casing consists of steel castings with flanges for attachment to supporting gusset plates. This view also shows the boiler and engines in place, as well as the taper wheel fit on the front end of the main shaft. The main shaft is 11⅛ in. in diameter and 12 ft. 2 in. long. The front bearing is 11⅛ in. in diameter by 28 in. long. Behind the front bearing is a marine type thrust bearing with 10 collars. There is a rear bearing 10 in. in diameter by 16½ in. long. The thrust bearing, which is peculiar to this plow, is intended to take up the thrust ordinarily

received by the back wall of the wheel casing. It has proved of decided benefit in service.

The engines are of the marine type and have cylinders 20 in. in diameter and 24-in. stroke. The supporting columns are cast steel. The crank pin of the engine was connected to a crank disc on the rear of the wheel shaft by means of a drag link coupling. This was used in case there should be any variation in alignment of the wheel shaft and engine crank shaft and to prevent any bending strains from being transmitted from one to the other.

The frames are box girders 36 in. deep at the front end. The outside plate of the girder is ⅜ in. thick and the inner ½ in. thick. The top and bottom members are 13-in. ship channels.

The boiler applied to these plows is similar to those of the Canadian Pacific class M-4 consolidation type locomotives. It has 2,108 sq. ft. of heating surface and 44 sq. ft. of grate surface, and is of greater capacity than any boilers that have been used for snow plow service.

The trucks are of the six-wheel type specially designed for the purpose, and have cast-steel frames. The axles have 7-in. by 12-in. journals, and the steel-tired wheels are 34 in. in diameter.

In working order, these plows weigh 260,000 lb. The weight is practically equal on the two trucks. The tender has a water capacity of 7,000 Imperial gallons and holds 16 tons of coal. It was made 32 ft. long over end frames, as, on account of bridge limitations, it was necessary to separate the weight of the plow from the weight of the pushing locomotives. The tender trucks are of the four-wheel, equalizer pedestal type, using standard engine-truck wheels and axles.

The performance of these plows has warranted their construction. An officer who has used them states that the knives are quite sufficient for dealing with small trees. They have cut trees 4 in. in diameter. He also states that the slight angle at which the cutting knives are placed makes the plow somewhat slower in its progress through a slide, but the knives do not break when they strike obstructions such as rocks and trees.

Flangers

In order to properly clean up the track and to clear out the space between the rails for a depth of from two to four inches, flangers are generally used. Flangers are applied either to the front of the locomotive, temporarily to box cars or flat cars, or permanently to snow plows or flanger cars. One of the early flangers used on locomotives was known as the Temple and Miller type. It consisted of a knife-like blade, one end of which was pivoted to the nose of the locomotive pilot. It was lowered and raised by means of lever connections from the locomotive cab, and when down in working position was practically parallel to the side of the pilot. The blade was made in two pieces. The lower one, which could readily be removed or replaced, formed the cutting plate or shoe, and was attached to the upper one by means of springs.

An improved type was known as the Priest flanger. Its general arrangement is similar to that of the Ray type, except that it was raised and lowered through a system of levers similar to those of the Temple and Miller flangers, the motive power being supplied by an air cylinder bolted beneath the running board of the locomotive. The manufacturers of the Priest flanger developed the Ray flanger. The air cylinders for raising and lowering the flangers are bolted to the cross tie which connects the front end of special truck equalizers. The flanger is held in raised position by a strong spring in each cylinder. The air is used only to keep the flanger down in operating position.

Ice Cutters and Sweepers

The formation of ice around and over tracks in yards is a cause of great delay. Removal by hand is slow and retards switching operations. To remove such ice quickly, the Canadian Pacific has developed and is using a type of ice cutter which is applied to the plow of a Jordan spreader car. The cutter consists of 29 two-inch square cutting tools of hardened steel, ground to a point at the bottom end. These knives are carried in a flanged channel which is fastened to the plow at the front of the spreader. This method of attachment permits the entire cutter to be raised and lowered by the existing spreader mechanism.

For removing ordinary light snows in yards, a few roads have used the well-known street railway type of sweeper. The revolving brooms at each end of the sweeper are operated by means of a single-cylinder reversible steam engine located in the body of the car. This engine takes steam from the locomotive pushing the sweeper. The writer has been advised that these cars are very efficient in removing light snow, and particularly in cleaning up terminals and terminal yards.

Operation of Equipment

Operation of equipment usually starts with the beginning of a storm. In clearing snow under ordinary conditions, pilot, push and wing plows are generally run at a good speed in order that the snow may be thrown well clear of the track. If the speed is slow the plow may catch or stall half way through the cut or drift, with the result that it may be stuck or buried and have to be shoveled out.

Particular care should be used on approaching a cut, particularly one with a side drift at the entrance, as with a double-track plow sufficient side pressure may develop to cause derailment. Such an approach is generally squared off before pushing the plow into it. If the snow is too deep for the plow to handle, it is leveled off by shoveling until reduced to a reasonable depth.

Rotary snow plows are handled in an entirely different manner from the push and wing plows. Instead of depending upon speed to get through the drifts, the rotary plow approaches the drift slowly and the cutting wheel is fed into the drift instead of bucking it. A snow bank or slide is generally approached at a speed of about three or four miles an hour with the rotary wheel revolving about 150 r. p. m. When coming close to the obstruction the speed of the wheel is increased, and the pusher engines keep moving just fast enough to keep the plow up against the drift. If the pusher engine crowds the rotary too much the pilot signals the engineer of the rotary to increase the speed of the wheel. In case the pusher engine still crowds the rotary, the pilot should apply the air brakes to check the pusher. If the pusher cannot be checked with the brakes, the pilot should signal the engineer of the pusher to shut off. He should respond quickly to prevent stalling the rotary. In case the rotary is stalled the flangers are raised and the plow drawn back four or five feet from the cut. When again ready, the wheel is started and pushed into the cut. The rotary plow should never be pushed into the bank from a distance of more than four or five feet, as failure of the rotary will result.

Discussion

Mr. Fuller: *I move you we accept the paper and extend a vote of thanks to Mr. Winterrowd for giving us this very interesting and complete history of snow fighting.*

This motion was adopted.

Adjourned.

Vauclain Trades Locomotives for Oil

WALL STREET TO-DAY (June 7) heard an interesting story which illustrates the ingenuity of some captains of industry in handling the puzzling exchange situation, according to the New York *World*. Recently Samuel Vauclain, president of the Baldwin Locomotive Works, came back from Europe with orders sufficient to keep the big Philadelphia plant busy for five years. Bankers wondered how he was to finance the orders.

"I have already arranged it," said Mr. Vauclain. "People used to trade before there was any such thing as money and foreign exchange."

He then explained that he had arranged the tentative payment by barter. Roumania needs $100,000,000 worth of locomotives, but she has little money and little credit. She did have, however, some of the richest oil fields in the world. Mr. Vauclain traded his locomotives for oil and oil options. He then went to the British Government and sold the oil at a handsome profit, payable in United States currency.

Registration Figures

CHAIRMAN GAYETTY, of the enrollment committee, announces that the comparative figures for Book No. 2 of the Official List of Enrollment is as follows:

	1919	1920
Members, Section III, Mechanical	458	490
Special guests	471	190
Railroad Ladies	550	344
Supply Ladies	350	490
Supply Men	1,825	1,955
Purchases and Stores	....	24
Total	3,654	3,493

These figures are not strictly comparable for the two years because the Car Builders met first last year.

Foreign Guests at the Convention

THE convention this year is to be particularly honored by several diplomatic representatives from foreign countries. Amongst those expected are:

Sir Auckland Geddes, British Ambassador to the United States.
Baron de Cartier de Marchienne, Belgian Ambassador.
Hipolit Gliwic, Commercial Counselor of the Legation of Poland.
Senor Manuell Y. de Négri, Commercial Attache, Mexican Legation.
V. P. Anaieff, Acting Commercial Attache to the Russian Embassy.
Capt. Carpenter, Assistant Commercial Attache to the Russian Embassy.
A. H. Saastamoinen. Finnish Legation.
Jarl Serlachius, Diplomatic Engineer, Finland.

Other foreign visitors are:

M. Santini, representative of the Paris, Lyons & Mediterranean,
Mr. Yamaguchi, Imperial Japanese Government Railway.
Walter L. Long, Assistant General Manager, United Fruit Company.
A. I. Lipetz, Chief Russian Railway Mission.

Significance of Senator Cummins' Victory

THE NEWSPAPER DISPATCHES carry the news that Senator Cummins has been renominated by the Republicans of Iowa over his opponent, S. W. Brookhart, by a large majority. This result has much significance from a railroad point of view. Mr. Cummins was one of the principal authors of the new Transportation Act. Brookhart is an advocate of government ownership, and based his campaign against Cummins chiefly on the ground that the senator had favored the return of the railroads to private operation under a fair law and had advocated the prohibition of railroad strikes and compulsory arbitration of labor disputes. The result is an endorsement by the Republicans of Iowa of the policy favored by Senator Cummins.

Yesterday's Entertainment

PRE-EMINENTLY the social event of the week was the grand ball on the Million Dollar Pier last night. All previous records for brilliancy and attendance were shattered to the seven winds. By 9 o'clock the 2,500 special dancing programs had been given out to members and their guests, and at 10 o'clock the Entertainment Committee estimated the attendance in excess of 3,500.

At 9.30 o'clock the enlarged orchestra began the grand march. It was perfectly carried out. It is doubted if the pier ballroom ever presented a prettier sight than when the 64 people abreast, one line closely following the other, in perfect alinement, slowly approached the pier entrance and came to a halt for the flashlight photograph. The exhibit booths on all sides of the ballroom and the galleries were crowded with ladies and gentlemen who had not taken part in the grand march.

The sub-committee in charge of the entertainment was as follows: R. J. Himmelright, chairman; Floyd Coffin, Oscar C. Hayward, William Melcher, S. W. Sargent, L. B. Sherman, Gardner Taylor, R. P. Townsend, W. M. Wilson and W. B. Wise.

A. R. A. Committee Meetings

J. E. FAIRBANKS, general secretary of the American Railroad Association, announces that the following meetings of committees and sections of this association will be held in Atlantic City within the next few days.

Meetings of the Committees of the Telegraph & Telephone Division, Section I—Operating, have been called to convene at The Breakers as follows:

Friday,	June 11, 1920—10.00 A. M.	Special Committee on Future Activities.
Saturday,	June 12, 1920—10.00 A. M.	Sub-Committee "A"—Maintenance and Construction of Pole Lines.
		Committee No. 6—Message Traffic
	2.00 P. M.	Committee No. 1—Construction and Maintenance—Outside Plant.
Monday,	June 14, 1920— 9.30 A. M.	Committee of Direction.
Tuesday,	June 15, 1920—10.00 A. M.	Committee No. 7—Inductive Interference.

The General Committee of Section VI—Purchases and Stores, will hold a session at the Marlborough-Blenheim on Sunday, June 13, 1920, at 11.00 A. M.

Section VII, Freight Claims, will hold a three-day session at the Chalfonte commencing Thursday, June 17, 1920.

The General Committee of that Section will hold a meeting at the Chalfonte on Wednesday, June 16, 1920.

The Committee on Operating Rules, Section I—Operating, will convene at the Chalfonte at 10.000 A. M., on Wednesday, June 16, 1920.

Senator Lodge "Roasts" Government Ownership

SENATOR LODGE, of Massachusetts, in his "keynote" speech as temporary Chairman of the Republican National Convention, paid his respects to government ownership and to the recent government operation of railroads in the following terms:

"The phrase 'government ownership' means not only that the government shall own the railroads, but also it is to be feared that those who run the railroads shall own the government.

"General government ownership under our political system would inevitably bring about the mastery of the government by those who operate the machinery of transportation or of any other industries which come into government possession. The rights of the general public, for whom all industries exist, would disappear under this scheme and nothing would be left to the people except the duty of paying taxes to support the roads. That is a very perilous position for a representative democracy.

"Our government must not be dominated by any one

man or any class or any selected body of men who represent a part of the people and not the whole people.

"During the time in which the government undertook to manage the railroads they sustained, despite a general increase in freight rate, a loss of over a million dollars a day and the total payments out of the treasury to support the railroads have reached the enormous sum of one and three-quarters billions of dollars. There was universal dissatisfaction with the government management and it was a just dissatisfaction. The experiment failed and should not be renewed."

Movies at the Convention

THE MOVIES HAVE MADE their appearance on many parts of the pier this year and have shown so many possibilities for enlarging the scope of the exhibits, particularly where the exhibitors' product cannot be demonstrated in action that next year is likely to witness a considerable extension of their use; in fact, it is not beyond the range of possibilities to picture the day when the pier will afford a range of movie attractions during convention days that will rival Broadway.

A great deal can be said in favor of the use of moving picture films in connection with the exhibits, and the exhibitors who have rigged up a screen deserve great credit for their ingenuity. The movies are not only extremely interesting and instructive, but afford the inquisitive visitor who has been on his feet all day a few moments' relaxation in which he can lounge back in a comfortable chair and see how they build locomotives down at Eddystone or where the Creco products are manufactured. But if he wants to see how they raise heavily loaded cars with Duff jacks he will have to stand on his tip-toes and peer over somebody's shoulder, as this feature film has been playing to capacity houses ever since the convention opened.

The Association of Manufacturers of Chilled Car Wheels have an excellent movie at booth 402, showing the various processes involved in manufacturing the chilled iron car wheel, including the molding, pouring, pitting and drop testing of the wheel. In addition to this, there are a series of pictures showing the measurement of temperature stresses to which the wheels are subjected, indicated by test gages. These pictures were secured through the courtesy of the officials of the Pennsylvania Railroad.

The Cleveland Pneumatic Tool Company has a miniature picture house in the back portion of booth 327, where you can experience all the thrills of attending a small town movie, save perhaps a chat with the pale blonde at the ticket window. This company is able to show more distinct pictures than is the case where the pictures are exposed to the daylight, and this is a feature that it might be well to bear in mind in preparing exhibits of this character next year, as unfortunately some of the pictures shown without any protection from the daylight are badly dimmed. The pictures shown by the Cleveland Pneumatic Tool Company include 4,000 ft. of film, illustrating all the details relating to the manufacture of modern pneumatic tools.

The Baldwin reel is making a record-breaking run in the balcony at booth 723. These pictures show general views of the Philadelphia and Eddystone plants of the company, also interior shop views showing such processes as the casting and machining of cylinders, the manufacture of forgings, and the finishing of frames, rods, crossheads and other parts. The construction of a locomotive boiler is illustrated from start to finish and there is also a series of pictures illustrating the erection of a locomotive and the running of a trial trip on the test track. Pictures of the gun mounts built for the United States navy are also shown.

The Chicago Railway Equipment Company's film is being shown on a small screen in booth 640, and gives a complete story of the manufacture of a brake beam from the acquisition of the raw material to the tested beam ready for application. All of the Creco plants are illustrated and impress one with this company's capacity for service, particularly on account of their control of the raw material.

The Scullin Steel Company, however, has a "reel" novelty in the form of an automatic motion picture machine that depicts the assembling and dismantling of this company's new universal and special types of pedestal truck side frames. This motion picture machine solves the usual difficulty that has been experienced in the use of action pictures for commercial or advertising purposes. All rewinding of the film is eliminated in this machine, which was designed under the personal supervision of the president of the Scullin Company, Harry Scullin, and will shortly be placed on the market for lease by the De Vilbliss Endless Film Machine Company, of St. Louis, a subsidiary of the Scullin Steel Company.

Last, but not least, the Purchases and Stores Section has promised to present a moving picture exhibition of a supply train in operation. This is to be featured in connection with the report of the Committee on Supply Train Operation, and will be presented in the Hippodrome on the pier, next Tuesday afternoon at three o'clock. As many storekeepers claim that the supply train is the *only* method for distributing materials out on the line of road, even up to ties and rail, the picture ought to prove interesting and mechanical officials are cordially invited to witness the performance in company with the Stores Section. It is understood that this picture comes from the Southern Pacific Railroad, and presumably was filmed in California. It is stated that the star's name is McKelligan, but probably it's just J. Warren Kerrigan. Helen Holmes, who used to do all the sensational stunts on moving trains, must be the heroine.

Registration, American Railroad Association, Sec. III, Mechanical

Anderson, H. A., A. P. A., Penn., Marlborough.
Balda, Frank E., Supt., Readville, N. Y., N. H. & H., Traymore.
Baldinger, F. A., M. M., B. & O.
Barry, J. J., Gen. M. M., N. & W.
Berg Karl, M. E., P. & L. E., Elberon.
Bixler, H. C., Supt., Penn., Marlborough.
Brower, J. E., Asst. M. M., Penn.
Buist, C. P., M. M., Public Belt, Marlborough.
Burket, C. W., Asst. Eng. M. P., Penn.
Burkhard, A. A., G. F., N. Y. C., Arlington.
Buskirk, J. H., M. E., N. Y. C., Chalfonte.
Calkins, A. E., S. R. S., N. Y. C., Chalfonte.
Carr, T. L., Gen. Foreman, Penn.
Clancy, T. B., Gen. Mgr., Central N. Y. Southern, St. Charles.
Copeland, A. H., Gen. For., G. T., Marlborough.
Cox, M. F., Mech. Eng., L. & N.
Crabbe, W. J., M. E., Western Maryland, Princess.
Cromwell, H. T., Asst. M. M., B. & O., Strand.
Daniels, O. V., Asst. Gen. Stkr., Penn.
Davis, John J., Gen. Foreman, Penn.
Dawson, E., M. M., Ariz. & New Mexico.
Demint, S. W., Chief Intercharge Inspector, Estelle.
Deets, Henry H., Gen. Forman, P. & R., Washington.
Dice, A. T., Pres., P. & R., Chelsea.
Doke, G. E., Asst. E. of T., N. Y. C.
Doyle, J. H., M. M., C. N. Y. S.
Dunkle, S. K., S. M. P., Wheeling Con. Rys.
Edmondson, O. N., Asst. M. M., Penn., Calvert.
Emerson, Geo. H., Chf. of M. P. & E., B. & O., Ambassador.
Ennis, J. E., A. F. R. S., N. Y C., Craig Hall.
Eyerly, W. S., Asst. S. of S., B. & O.
Ewing, C. H., V. P., P. & R.
Falck, F. M., Gen. Manager, P. & R.
Faris, J. M., S. M. & E. Dept., Youngstown, Shat. & Tube Co.
Fassett, W. H., Chairman Div. Safety Com., Penn.
Gibson, J. A. B., M. E., R. F. & P., Chalfonte.
Gilland, James M., Transportation Asst., P. & R.
Graham, H. E., V. P., P. A. & McK. Rocks, Traymore.

Gray, B. H., S. M. P., G. M. & N., Princess.
Greenwood, H. F., S. S., N. & W., Marlborough.
Hall, James, M. C. R., S. P., Chalfonte.
Hammond, F. S., Gen. Supt., Pitts., Shawmut & Nor., Princess.
Hammond, R., M. M., N. Y. N. H. & H., Elberon.
Hazzard, W. L., Supt. Material Routing, N. Y. C.
Heinbach, Wilfred, Gen. Foreman, P. & R., Gage.
Hill, J. P., Dir. Stkr., Penn.
Hitchcock, W. D., M. M., Santa Fe, Ambassador.
Hoch, G. B., Gen. Foreman, Penn., Shelburne.
Huber, H. G., Asst. Engr. M. P., Penn., Chalfonte.
Hudson, T. C., Gen. M. M., Can. Nat. Rys., Marlborough.
Hyland, W. V., Gen. Mgr., Ligonier Valley, Marlborough.
Irvin, I. B., M. M., P. S. & N.
Jones, H. W., M. M., Penn., Elberon.
Jones, L. B., M. M., Penn., Dennis.
Jones, W. F., G. S. K., N. Y. C., Chalfonte.
Kelly, G. W., Gen. For., C. of N. J., Sterling.
Kelly, W. M., Gen. For., Penn.
Kerlily, J. J., M. M., B. & O.
Kneass, Strickland L., Wm. Sellers Co.
Kuhn, W. T., S. M. P., T. H. & B., 121 S. New Jersey Ave.
Lace, R. F., Gen. For. Loco. Dept., Penn., Elberon.
Leonard, L. R., Gen. A. B. & S. H. Inspr., Penn.
Lightfoot, S. S., Equip. Eng., A. T. & S. F., Esplanade.
Lipctz, A. I., Ch. Russian Mission of Ways & Communications, Marlborough.
Lower, M. J., A. G. M., Oswasco River.
McClennan, W. J., Asst. Eng. of Equip. Claims, N. Y. C., Ambassador.
McMaster, H. M., V. P. & G. M., W. & L. E.
Markland, W. H., Gen. Shop Insp., Penn.
Marsh, F. E., M. M., N. Y P. & N., Traymore.
Martin, H. W., Supt., Kinzua & Riterville.
Morris, J. M., M. M., Penn.
Morris, J. S., Asst. Engr. M. P. Dept., N. Y. C. & St. L.
Newreither, W. H., Gen. Fore., B. & O., Pleasantville.
Milner, B. R., Eng. M. P. & R. S., N. Y. C., Haddon Hall.
Miscampbell, J., M. M., Ft. Smith & Western, Ambassador.
Muelheim, L. C., Head. Light Sup., B. & O., Haddon Hall.
Nanney, T. H., M. M., Buffalo & Susquehanna, 935 Boardwalk.
Needham, H. S., Asst. M. M., Penn., Elberon.
O'Meara, William I., Road For. Elec. Loco., New Haven, Glaslyn-Chatham.
Owens, W. H., M. E., Southern, Osborne.
Pidcock, C. W., Pres., Ga. & Nor., Chalfonte.
Ralston, A. L., Mech. Supt., N. Y. N. H. & H., Glaslyn-Chatham.
Rauschart, E. A., M. M., Montour, Princess.
Reese, O. P., Penn., Marlborough.
Rice, W. L., Supt., L. & C. S. P. & R.
Riley, S. B., M. M., Penn., Chalfonte.
Robbins, F. S., M. M., Penn.
Sample, W. H., G. S., M. P. & C. D., Grand Trunk, Marlborough.
Sasser, J. W., S. M. P., N. S., Ambassador.
Scudder, C. J., Supt. of Shops, D. & L. & W., Traymore.
Shafer, S. W., Ch. Cl. to P. A., C. R. of N. J.
Sheahan, J. F., S. M. P., A. B. & A., Chalfonte.
Shelby, C. K., M. M., Penn., Chelsea.
Smith, E. W., Engr. of Transp., Penn., Chalfonte.
Smith, P. W. J., Gen. Supt., N. Y. Westchest. & Boston, Glaslyn-Chatham.
Smith, W. T., Craig Hall.
Snell, E. J., M. M., N. Y. C.
Snyder, F. M., Gen. For., Penn.
Sprowl, N. E., S. M. P., Atlantic Coast Line, Chalfonte.
Stewart, A. F., Traymore.
Stohlberger, P., M. M. M. P. & R. E. Dept., P. & R.
Summerfield, D. W., P. A., P. & W. Va.
Tate, M. K., Manager Service, Lima Loco. Works, Traymore.
Thayer, R. E., European Editor, Railway Age, Dennis.
Thomson, H. R., M. M., N. & S. S., De Ville.
Turner, Ames, M. M., Lehigh Valley.
Van Brunt, Geo. E., M. M., Penn., Schlitz.
Wagstaff, Geo., American Arch Co., Chalfonte.
Wallis, J. P., C. M. P., Penn.
Watkins, Thomas, Gen. Foreman, P. & R.
Way, E. S., S. E., Gen. Amer. Tank Car Corp., Haddon Hall.
Williams, A. D., M. M., Kansas City Southern, Estelle.
Williams, M. E., M. M., P. & R.
Wilson, D. H., Shop Supt., Florida East Coast, Sterling.
Wilson, J. O., Mgr. Mech. Dept., The Texas Co, Traymore.
Wray, R. W., M. M., Penn.
Young, Jas., Jr., Asst. Eng. M. Dept., West Jersey & seashore.

Special Guests

Alcorn, A. E., P. A., W. J. & S. S.
Allen, Wm. H., Supt. of M. P., Penn.
Andrew, A. G., Sup. M. of N., Penn.
Baldinger, Robert, B. & O.
Baldinger, Stephen, B. & O.
Barron, C. M., Mech. Eng., New S. Wales Gov. Railways, St. Charles.
Betts, E., Asst. Eng., So. Pac., Traymore.
Buckley, Thomas F., Asst. For., P. & R.
Carroll, J. S., M. Equip. Clerk, Penn.
Cathcart, Harold W., Fire Insp., A. C.
Clarkson, A. J., Sr. Draft. Eng. Dept., N. Y. C.
Conen, J. J., Supvr. Shop Practice, B. & O., Netherlands.
Coulter, A. S., Commissary Agent, W. J. & S. S.
Crabbe, W. Joseph, W. M., Princess.
Daniels, Geo., Penn.
Darlow, E. R., Pres., Buff. & Sus.
Darlow, G. M., Rate Clerk, Buffalo & Sus.
Dietrick, J. C., For. Car Shops, Penn., Elwood.
Downs, J. H., Ret. Asst. Rd Fore. Eng., Penn.
Draney, J. J., Engineman, D. L. & W.
Eddy, J. C., Traffic Engineer, New Jersey Public Utility Com., Pennhurst.
Ehrich, Thomas J., Reporter, Canfield.
Eleade, W. E., Jr., Secy., N. E. R. R. Club, Arlington.
Filippelli, F. P., Transitman M. of W., Penn.
Fisher, C. A., Ch. Train Disp., P. & R., Dennis.
Fisher, V. B., Supt., P. & R., Princess.
Gall, H. S., A. B. I., Penn.
Gallagher, John E., For. of Eng., C. R. R. of N. J., Princess.
Gardner, Henry, Jr., B. & O., Chalfonte.

Conventionalities

G. W. Denyvan of the entertainment committee, who has always stopped at the Dennis Hotel, was not able to obtain his usual rooms because of the noise made by the bagpipes he used at the convention last year.

Frank T. Hyndman, now with the American Automatic Company, motored down from Buffalo with his wife and his daughter-in-law, Mrs. R. M. Werner, and with his two grandchildren, Mary and Frank Werner.

C. H. Aiken, special representative of the Falls Hollow Staybolt Company, has called all sales agents of that company to Atlantic City to attend the convention and also hold a special sales convention of their own organization.

L. S. Carroll, formerly purchasing agent of the Chicago & North Western, will come to the convention this year in a new capacity, he having recently been appointed general purchasing agent of the American Locomotive Company.

Among the mechanical officers who have gone into the operating department during the past year is E. W. Smith, formerly superintendent motive power, now engineer of transportation of the Pennsylvania system. Mr. Smith has not lost interest in mechanical matters, however, and is attending the convention as usual.

Vice-President J. A. MacLean, of the Boss Nut Company, enjoyed a pleasant trip to Atlantic City. In company with Fred W. Moore, of the Boss Lock Nut Company, Ltd., Mr. MacLean motored from Montreal to the convention city. The trip took two and a half days, over good roads and with pleasant weather.

B. J. Meyer, former special representative of the department of justice in Chicago, and for the past four years connected with the Great Western Smelting and Refining Company, has been appointed assistant to the president of his company, in charge of railroad sales. Mr. Meyer is stopping at the Marlborough-Blenheim.

Mr. and Mrs. J. W. Motherwell are accompanied to the conventions this year by their daughter, Miss Ruth, who has just graduated from Northwestern University at Evanston, Ill. Miss Ruth, in order to attend the conventions, had to forego the privilege of attending the graduating exercises at the university, and she paid the conventions the compliment of preferring to come here.

W. O. Thompson, general superintendent of rolling stock of the New York Central, like many other railway officials, did extra duty during the recent strikes. He served for a week as a yardmaster at Buffalo; and those familiar with his performance record agree that both his methods of handling the job and his vocabulary proved entirely equal to the demands.

Two representatives of the Chicago, Milwaukee & St. Paul are receiving congratulations on recent promotions. C. G. Juneau, general supervisor of the freight car department, has been appointed acting master car builder to succeed L. K. Sillcox; and J. A. Deppe, assistant to the master car builder, has been made general supervisor of the freight car department.

M. E. Towner, purchasing agent of the Western Maryland, was one of the first members of the Purchasing and Stores Section to arrive at the convention. Mr. Towner expects to move into the Western Maryland's new office building in Baltimore at an early date. He is specially interested in several of the reports of Section III, Mechanical, and particularly the one on shop scheduling systems which was presented yesterday.

Norman C. Naylor, of the Railway Steel Spring Company, is one of the leaders among the Chicago men who not only play golf well, but are putting and keeping the golf clubs in the Chicago district on a sound basis from the standpoint of good management as well as good sport. He is president of the Westmoreland Country Club and also vice president of the Chicago District Golf Association.

J. Horrigan, superintendent motive power of the Elgin, Joliet & Eastern, is one of the early arrivals at Atlantic City. Mr. Horrigan's shop has made an enviable record in safe-ending boiler tubes, and Joliet is becoming a Mecca for men who are seeking information on the best methods of doing this work. The Elgin, Joliet & Eastern car shops have recently started building six hundred 70-ton hopper cars.

George E. Long, of the Joseph Dixon Crucible Company, is one of the old guard who will not be here this year. Mr. Long has always declared that when he reached 70 years of age he would step out of business and enjoy the remaining years. He has been connected with the Joseph Dixon Crucible Company for 43 consecutive years, retiring from the position of vice-president only recently.

In the interest of sanity and economy we would refer our many friends with budding ambitions toward aviation to visit the Barco booth. Perch yourself on their engine connection and holler for the juice to be turned on and you're due for all the fancy wiggles and bends in the deck. It won't cost you anything and you may learn a few fancy movements that will make a hit on the dance floor.

Mrs. Henry G. Ashton, widow of the late Henry G. Ashton, founder and president of the Ashton Valve Company, is again in attendance at the conventions. Her first convention visit was at Cleveland, Ohio, where the associations met in 1877. She has since been a regular attendant, with one or two exceptions, ever since. Mrs. Ashton is at the Marlborough-Blenheim with her son and daughter, Mr. and Mrs. A. C. Ashton.

President E. B. Leigh, of the Chicago Railway Equipment Company, is expected to arrive at the Traymore Sunday morning. Vice President C. Haines Williams is expected Monday. E. E. Greist's delay in arriving is due to the fire at the Franklin plant of the company. Mr. Griest, however, is expected Sunday and will stay through the remainder of the convention.

John Draney, engineer of the Lackawanna's crack train No. 6, the Lackawanna Limited, is celebrating his thirty-fifth wedding anniversary at the convention with his wife and youngest daughter, Helen. They expect to remain over until Saturday or Sunday. Mr. Draney wears a watch charm which was presented to him in recognition of breaking all records in the run from New York to Buffalo. He carried Dr. Janeway on a special train when President McKinley was assassinated, making the run of 410 miles in 6 hours and 55 minutes.

Mrs. V. R. Hawthorne had a thrilling experience in Chicago shortly before she started for the convention. She had been on a shopping expedition and among other things had purchased a lace curtain and an oak curtain pole. Near Sixty-third street she was held up by a man who demanded her pocketbook. She told him that it was in her waist and if he would hold the bundle containing the lace curtain she would get it for him. He took the bundle and she quickly hit him over the head with the curtain pole, knocking him unconscious and relieving him of two or three of his front teeth. By that time assistance had arrived and the robber was taken to the police station.

George C. Isbester is attending the conventions this year after an absence from them of 13 years. He last attended them when he was with the Railway Appliances Company. He comes this year as district sales manager of the American Chain Company at Chicago. Mr. Isbester left the railway supply mechanical field in 1912, when he went with the Rail Joint Company as its district manager in Chicago. On the very day in April, 1917, when the United States entered the war with Germany, he left civilian life and became a commander in the supply corps of the United States navy. He was first located in this capacity at Chicago, and in the early part of 1918 was transferred to London, where he served on the staff of Admiral Sims. He returned to the United States in April, 1919, and immediately after returned to civilian life. Soon after he became district sales manager of the American Chain Company. Mr. Isbester for years has been active in the work of the National Railway Appliances Association, which gives the exhibit of railway appliances in connection with the annual conventon of the American Railway Engineering Association in Chicago in March of each year. He is now vice-president of the Railway Appliances Association and is carefully looking over the exhibit here for any pointers that he may be able to get for use in connection with the exhibit in Chicago.

Mr. and Mrs. John P. Landreth gave a theatre party at the Apollo Theatre on Wednesday evening, which had more sentiment in it than the ordinary theatre party. The performance was that of the musical comedy, "Maid To Love," which is being given its initial performances in Atlantic City, and the author of the music of which is Percy Wenrich. Over 20 years ago Mr. Landreth and Mr. Wenrich were schoolmates and playmates at Joplin, Mo., and they have continued to be intimate friends ever since. Mr. Wenrich is the author of much music which has become famous, including that of the songs "Put on Your Old Gray Bonnet," "Where Do We Go From Here," and "When You Wore a Tulip and I Wore a Big Rose." One of the members of the party was J. Will Johnson, who is an old Missouri friend of Mr. Wenrich's mother. Other members of the party were C. C. Higgins, J. D. Rodger, J. S. Henry, C. R. Naylor, John Purcell, C. T. Ripley, J. E. McQuillen, J. H. McGoff, Mr. and Mrs. Claude Baker, H. T. Bentley, Miss Louise Bentley, Mr. and Mrs. E. S. Richardson, George H. Green, T. A. Foque, H. C. Manchester, R. C. Schaal, H. W. Schaefer, Charles R. Long, Jr., H. Clark Moore, C. F. Owens, F. A. DeWolf, Ralph Coburn, Mrs. A. A. Cannady, Mr. and Mrs. J. C. Weedon, Mr. and Mrs. H. B. Walls, F. W. Thomas, Major W. L. Allison, and Mary Virginia Landreth. All the members of the party agree that in writing the music of "Maid To Love," Mr. Wenrich has lived up to the high reputation established by his past productions, and that the show is sure to be successful and have a long run.

European Railway Observations

By Robert E. Thayer

European Editor, Railway Age

Oil Locomotives in France

The coal situation in France has become so acute that the railways are seeking to alleviate the situation by the use of fuel oil for locomotives. The Paris, Lyons & Mediterranean is making experiments with ten of its locomotives, and if they prove successful 200 or 300 others will be converted. An oil tank containing 320 gallons is placed on one side of the locomotive, no other changes being made in the engine with the exception of the necessary brickwork in the firebox.

Foreign Railway Visitors

One very good means of furthering the foreign business of the United States, particularly as regards railway equipment and material, is to give the foreign railway men visiting this country every facility to study and investigate our railway plant and our railway methods. The conditions on the railways of foreign countries, particularly the railways in Europe, have undergone a very decided change and have approached, to some extent, the conditions which have for many years existed in the United States. The cost of railway labor and the cost of materials have increased to an greater extent in Europe than in the United States and the European railways are faced with a new problem. They must operate more efficiently and devise every possible means of cutting down labor costs. In the latter feature particularly they can well look to the railways of the United States for suggestions and that they are, is apparent from the way in which they are beginning to interest themselves in American railway practice.

A Railway "Personnel" Bureau

Sir Henry W. Thornton, K. B. E., general manager of the Great Eastern Railway, England, and formerly of the Long Island, offered a very good suggestion for increasing the esprit-de-corps amongst the railwaymen, in a recent address before the Institute of Transport (England). He said that he thought we had now arrived at a time when, quite apart from the functions of each officer and department, it would be advantageous to establish on each large railway an organized "personnel" bureau, administered by an officer of first rank, with the poper temperament, who should make it his business to deal with all matters affecting the welfare and working conditions of the staff, to seek out their grievances and complaints and bring them immediately to the attention of the proper officer for adjustment. Through accessibility, through the sympathetic hearing and the just determination of controversies, the confidence of the staff could be gained.

Foreign Railway Shops Need Improved Devices

Many of the managers of the railway shops in Europe are very frank to admit that there is great need for improved shop machinery and more up-to-date methods in their shops now that labor costs have risen to such a great extent. For many years they have been blessed with cheap labor and have not been forced to the use of labor saving devices as have the railway shops in America.

A specific instance found in one railway shop will serve as an excellent illustration. All boiler tubes are swaged by hand in that shop. A small cup-shaped die is placed on a heavy iron plate in the floor and the tube, held in a vertical position by the workman, is jammed into this die sufficiently hard to grip it. Then the tube and the die is raised and thrown by brute force onto the plate in the floor until the tube has been properly swaged. Needless to say, this takes considerable time as the workman is continually reaching down to refit the die onto the tube. Although this is a small item and is an extreme case of inefficiency, it gives somewhat of an idea of how little labor costs have been considered in railway practice abroad.

Railway Labor in France

While the railway men of France are being used by the extremist labor leaders as a medium through which they can inflict their bolshevist demonstrations on the people of France, the railway employees have as a class been amply taken care of in the way of increased compensation. Railway labor in France has not suffered from the lack of increases in wages. Before the war the wage bill did not reach 800,000,000 francs ($160,000,000) on the six principal railway systems. To-day it is 3,500,000,000 francs ($700,000,000), or an increase of some 350 per cent. This increase is accounted for to a certain extent by the fact that the number of employees has increased by some 50 per cent, but at the same time increases to the men themselves vary between 200 and 350 per cent of the pre-war wage. All sorts of concessions are given the French railwayman in addition to a general increase in wages. He receives a residential compensation of a varying amount, depending upon the location in which he lives. In Paris this amounts to 1,200 francs ($240) a year. He also receives 720 francs ($144) a year as a bonus to meet the high cost of living. In addition a married man receives 330 francs ($66) for each of his first two children and 480 francs ($96) for each other child. Even with the increase in freight and passenger rates recently granted it is estimated that in view of this great increase in wages the expenses of the railways will not be met by earnings by at least 500,000,000 francs ($100,000,000).

English Enginemen Receive Increases

Wireless to the Daily Railway Age.

The Railway Wages Board of Great Britain has awarded an increase of seven shillings ($1.75) a week to locomotive engineers, four shillings ($1.00) to firemen of 10 years' service and under, seven shillings ($1.75) to firemen of over 10 years' service and two shillings ($.50) to cleaners. This is the result of a hearing which began May 17 on the demands of the Associated Society of Locomotive Engineers and Firemen for an advance of 27 shillings ($6.75) a week for engineers, 21 shillings ($5.25) for firemen and 15 shillings ($3.75) for cleaners. During the course of the hearing it was stated that if the full demands of the union were granted it would involve an additional charge to railway expenses of $15,000,000, which under present conditions could not be met out of the present railway revenue. With this last award a locomotive engineer will receive a daily (eight hours) wage varying from 16 shillings ($4.00) to 13 shillings ($3.25) according to length of service; a fireman will receive from 10 shillings ($2.50) to 12 shillings ($3.00), and cleaners will receive from four shillings three pence ($1.06) to seven shillings three pence ($1.81). The Railway Wages Board is made up of four representatives each from the railwaymen, the railway managers and the public.

The Man Who Saw

Smile, Durn Ye, Smile!

The Man respectfully submits that the mail bag which he installed yesterday for the use of his friends went to work at once on a 6-hour day basis and time and a half for overtime. It is bursting with protests against Hum Dinger's Prune Plan—and contained the following, from old friend Kronick Kicker:

The Man Who Saw.
Care of The Mail Bag.

Sir:

The wet steam from your leaky cylinders is causing the driving wheels in your head to slip. You had better put on a superheater for dry steam and an air sander to hold you to the track; cut out the frivolity and the ancient wheezes. Give us serious dope—that's what we came here for. We can read your kind of stuff in the barber shop.

K. K.

Thanks for the ad, K. K., the Man's column is not for you and the gloom dispensing crepe hangers. It's for those who believe that—

"A little nonsense now and then
Is relished by convention men."

The Motion Increases

The Man hasn't seen the "daddy" of it, whom he mentioned last year as having several years ago pioneered the operating exhibit under a sign which read

LOOK WHAT'S COMING OFF HERE

—but the motion is here, and more of it than ever. And there's no question of the value of motion in the exhibit—they'll just naturally hang around it like flies around a molasses jug!

And the infection is spreading to pictures. If you want to see how it's made and how it goes on, sit down—we'll go out to the factory a 1000 miles from here without moving a hair and we'll make one for you. Then we'll put it on the car or the engine—as the case may be—and we won't speed up the film to fool you on the time. When we get it on, we'll go out on the line and see how it works.

"Say," said the Man to the progressive exhibitor as he finished the interesting trip out on the line, "I think I've got a cinder in my eye. Will you look at it?"

Assorted Railroads

"Tell me" said the Supply Man to the Man Who Saw South America, "what are South American railroads like? Is it true that the sparks from wheezy old wood-burners set fire to the clothes of the passengers?"

"You've asked for more than I can tell you in the few minutes at your disposal," replied the Man Who Saw, "but I'll give you an outline. You can find railroads down there to suit the tastes of most anybody—long, short, wide, medium and narrow gage; rich, poor, French, American, and lines administered by native governments. Last, but foremost in numbers and importance, British roads.

"The first English owned road you will se in your descent of the West Coast, The Central and the Southern of Peru will surprise you by its quota of American locomotives and cars. In Bolivia you will encounter British engines, British practices and British conceptions of American cars on the narrowest little ralroad—and one of the most comfortable—you ever traveled on. In Chile you'll see the Chilean Government lines and if you will look far enough you will find equipment of all makes—French, English, American, German—all kinds. It's a wide open market. The Trans-Andine railroad is British and of meter gage. Its connection on your arrival in the Argentine, is British—as is nearly everything else with the important exception of a French line and the Argentine Government railways. Ascending the East Coast you will encounter English lines dominating the traffic of Uruguay and Paraguay. In Brazil you will find three large and powerful British lines and the Brazilian Government railways.

"There's rack rail, cable operated inclines, 300 foot radius curves where special journal box lids are required to take care of excessive axle thrusts, leather water spouts and dormitory cars as big as hotels on wheels, red driving wheels and enough brass on some engines to decorate the altar of a church, and the variety of characteristics of the lines is only exceeded by that of the scenery."

"Could I sell 'em anything?" eagerly enquired the Supply Man.

"Ah, that's another matter," replied his friend, "Come and see me and I'll take a day off and tell you."

The College Man Goes to Work

"I hear you're a college man," said the superintendent of machinery to the grimy apprentice who was putting a brake shoe on the right main driver of the 'yard goat.'"

"Yes, I did manage to get through a fairly good engineering school in spite of predictions to the contrary," replied the youth.

"What do you do here?" questioned the boss.

And the young aspirant related his simple but arduous duties in the night gang at the roundhouse, whose nightly grind called for less brains than elbow grease—and paid in proportion. The old man almost felt himself slipping in his ancient grudge against the "book taught" crowd of "railroaders on paper," as he called them, as he listened to the tale.

"Come around to see me when I get back next week," invited the old man.

"Thank you, sir," was the answer, "but I won't be able to come. I am quitting on Saturday to go with the Progressive Machinery Company."

The old man turned on his heel—*and thus let him get away!*

* * * *

The Man Who Saw was that youth in the pit and that old man was a shining exponent of the clan known as the "old school" of motive power officials, a species of fish that is gradually, but painfully, retiring in the glare of progressive business methods from the electric headlight of a new age.

And The Man from his seat by the Mail Bag takes pleasure in the "talk that's going round" the Pier among the live ones this year on the subject of the college man on the railroad. He earnestly hopes—as he thinks of Goode and Wickersham and Cunningham and Gregg and the others, who, inspired by the call of a Western railroad, tackled it, but surrendered in disgust—that the successors of his disappointed old pals will be given a chance to enjoy their railroad work with assurances of such recognition as they deserve.